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CORRECTIONS

Monthly Weather Review, November, 1929:

Page 455, first column, third line from end of paragraph, "Labore" should be "Lahore."

Page 463, second column, last paragraph, third line, "alternation" should be "alteration."

MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

VOL. 58, No. 1
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CYCLONES AND ANTICYCLONES OF THE NORTHERN HEMISPHERE, JANUARY TO APRIL, INCLUSIVE, 1925

By CHARLES L. MITCHELL

[Weather Bureau, Washington, December, 1929]

SYNOPSIS

INTRODUCTION

There has arisen during the past several years an insistent demand for daily synoptic weather maps of the entire Northern Hemisphere. It has been realized for a long time that a chain of meteorological stations along or near the Arctic Circle is essential to a proper study of pressure and temperature conditions over the entire hemisphere with the objective in view of forecasting weather and temperature for a week or more ahead with a satisfactory degree of accuracy. Furthermore, the additional knowledge of the behavior of the large masses of cold and of warm air will enable forecasters to increase the accuracy of their 36 to 48 hour forecasts.

The difficulties in the way, especially in regard to means of instantaneous communication, have prevented the consummation of such a plan up to the present time, but the amazing progress made during the last two or three years in perfecting high-frequency radio transmission with low-power transmitters encourages meteorologists to believe that the dream of a complete daily weather map of the Northern Hempishere will be realized within the next few years.

It is regrettable that, as pointed out by Henry,[1] the international polar stations of 1882 were established at a time when a very wide gap (1,200 miles or more) separated them from the northern border of the existing network of meteorological stations to the southward. It was not possible, of course, to utilize the results of the polar stations in the day-to-day forecasting of that time.

So far as the writer has been able to ascertain, no daily meteorological data have ever been published for the Siberian coast from the mouth of the Lena River to Bering Strait—a stretch of 1,356 miles embracing 60 degrees of longitude—nor for the 75-degree stretch from the mouth of the Mackenzie River eastward to the Greenland coast, about 1,675 statute miles. Data received either currently or by delayed mail from Point Barrow, Alaska, the lower Mackenzie Valley, Greenland, Jan Mayen, Spitsbergen, Nova Zembla, and the mouth of the Yenesei River have made it possible to construct charts showing fairly well for recent years the pressure distribution over the polar region. However, it has remained a disputed question as to the origin of the outbursts of polar air that frequently move southeastward over the British Northwest Territory and northern and eastern Alaska.[2]

AMUNDSEN EXPEDITION

Contribution by Sverdrup.—During the autumn of 1925, H. U. Sverdrup, meteorologist of the Amundsen expedition on the *Maud* during the years 1922–1925, lectured to the scientific staff of the Weather Bureau at Washington. He told of the meteorological work during the period that the *Maud* was frozen fast in the ice near Bear Islands off the Siberian coast at latitude 70° 40′ N., longitude 162° 25′ E. Upon learning that I had planned to make a study of outbursts of polar air over northeastern Siberia and northern North America, he kindly furnished complete twice-daily observations taken on the *Maud* during the period from January 1 to May 14, 1925. At that time (1925) the Weather Bureau was receiving daily data covering the rather limited area as shown on the map (isobars only) of December 31, 1924. (Fig. 1.) With the *Maud* data as a nucleus the great uncharted area of the Northern Hemisphere was gradually filled in with data secured from various sources until finally it was practicable to construct quite complete charts such as the one of February 28, 1925. (Fig. 2.)

OBSERVATIONAL MATERIAL AVAILABLE IN 1929 FOR CONSTRUCTING THE DAILY WEATHER MAP

At the present time (1929) reports are received at Washington each morning from more than 250 stations in North America, Greenland, and the West Indies, all of which, together with numerous reports from vessels in the Caribbean Sea, the Gulf of Mexico, the western Atlantic Ocean, and the eastern Pacific Ocean, are entered

[1] Henry, A. J., Whence Come Cold Waves, MONTHLY WEATHER REVIEW, 56: 143.

[2] Loc. cit. p. 144.

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on the forecast charts. On the weather maps of the various meteorological services of Europe, Asia, and northern Africa there are published a total of nearly 600 reports. About 275 of these are from stations in Europe, 57 from northern Africa, almost 150 from stations in India, and about 115 from stations situated elsewhere in Asia (including the Philippines and the Japanese Archipelago). Thus there are available (lacking only means of transferring them to some suitable center) daily meteorological reports from more than 850 land stations in the Northern Hemisphere, besides reports from at least 100 vessels. Of course it would be neither desirable nor practicable to collect and publish all of these available reports at any one collecting center. Reports would be needed at Washington from only a small percentage of the meteorological stations in Europe, India, and extreme northern Africa.

Data from Point Barrow for the first four months of 1925 were secured from reports received by mail; data from stations in the British Northwest Territory were copied from the Canadian Monthly Record of Meteorological Observations, and the European and Siberian data from Leningrad and Vladivostok maps. The maps of the Italian, Egyptian, and Algerian meteorological services were also of value in completing the charts for the more southerly latitudes, and the daily maps of the Kobe, Japan, and Zi-Ka-Wei, China, observatories furnished valuable data for the

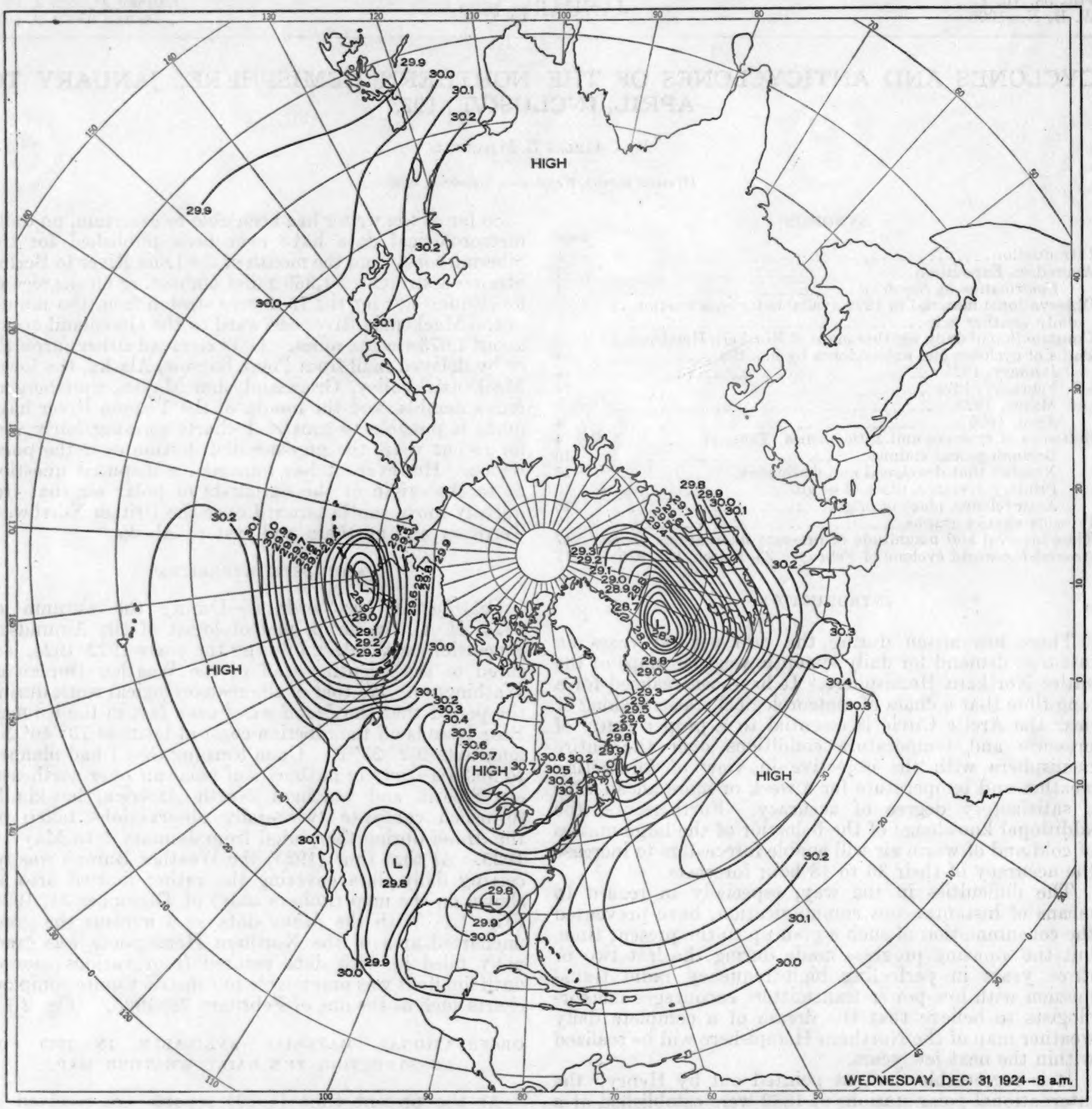

FIGURE 1.—Isobars, Northern Hemisphere, 8 a. m. seventy-fifth meridian time, December 31, 1924

western Pacific Ocean and the Asiatic coast south of the Sea of Okhotsk. Quite a gap still existed in northern regions, however, comprising the vast area from the Mackenzie Valley and Lake Winnipeg eastward over the remainder of British North America and all of Greenland. It was learned that the Danish Meteorological Institute maintained a number of regular observing stations in Greenland (reporting by mail at that time, but now by radio), and, upon request, the director of the Danish service furnished twice-daily reports from six places, the most northerly one being Upernivik at latitude 72° 47′ N., longitude 56° 7′ W.

During a visit to the central office of the Canadian Meteorological Service at Toronto the very gratifying information was obtained that regular reports were available from a few places in the Hudson Bay-Baffin Land region. Copies of twice-daily observations made at the following stations were obtained: Chesterfield Inlet and Port Harrison, both on Hudson Bay; Fort Chimo, near the eastern end of Hudson Strait; and Ponds Inlet, in Baffin Land at latitude 72° 43′ N., longitude 78° 30′ W.

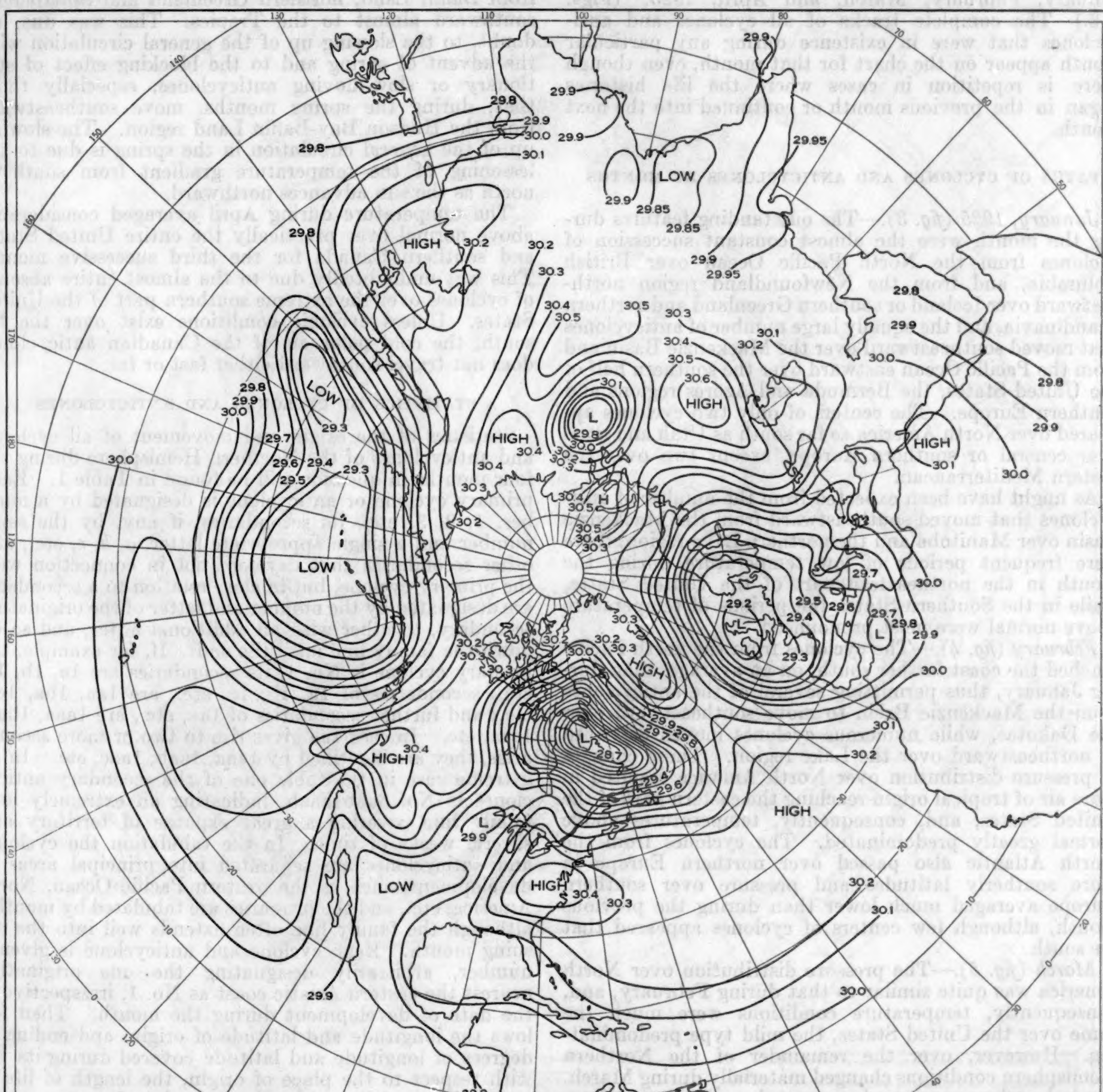

FIGURE 2.—Isobars, Northern Hemisphere, 8 a. m. seventy-fifth meridian time, February 28, 1925

CONSTRUCTION OF DAILY WEATHER MAPS OF NORTHERN HEMISPHERE, JANUARY–APRIL, 1925

After entering data from all stations near or above the Arctic Circle and from selected stations below that Circle on the daily a. m. Northern Hemisphere weather

maps, the isobars were extended to include all cyclones and anticyclones of consequence of the entire hemisphere.

The paths of all cyclones and anticyclones and the location of the centers each 24 hours, as well as the approximate location of the place of dissipation or disintegration, were carefully plotted for the months of January, February, March, and April, 1925. (Figs. 3-6.) The complete tracks of all cyclones and anticyclones that were in existence during any particular month appear on the chart for that month, even though there is repetition in cases where the life histories began in the previous month or continued into the next month.

PATHS OF CYCLONES AND ANTICYCLONES BY MONTHS

January, 1925 (*fig. 3*).—The outstanding features during the month were the almost constant succession of cyclones from the North Pacific Ocean over British Columbia, and from the Newfoundland region northeastward over Iceland or southern Greenland and northern Scandinavia, and the equally large number of anticyclones that moved southeastward over the Mackenzie Basin and from the Pacific Ocean eastward over the southern half of the United States, the Bermuda and Azores regions and southern Europe. The centers of only two cyclones appeared over North America as far south as Utah and none over central or southern Europe, except two over the eastern Mediterranean.

As might have been expected from the number of anticyclones that moved southeastward from the Mackenzie Basin over Manitoba and the northern Lake region, there were frequent periods of low temperature during the month in the northeastern part of the United States, while in the Southern States the periods of temperature above normal were most pronounced.

February (*fig. 4*).—The cyclones from the north Pacific reached the coast farther south, on an average, than during January, thus permitting several of the anticyclones from the Mackenzie Basin to move southeastward over the Dakotas, while numerous cyclones moved eastward or northeastward over the Lake region. These changes in pressure distribution over North America resulted in more air of tropical origin reaching the eastern part of the United States, and, consequently, temperatures above normal greatly predominated. The cyclones from the North Atlantic also passed over northern Europe in more southerly latitudes and pressure over southern Europe averaged much lower than during the previous month, although few centers of cyclones appeared that far south.

March (*fig. 5*).—The pressure distribution over North America was quite similar to that during February, and, consequently, temperature conditions were much the same over the United States, the mild type predominating. However, over the remainder of the Northern Hemisphere conditions changed materially during March. Several cyclones appeared over southern Europe and extreme northern Africa, and few cyclones, but several anticyclones, passed over the British Isles. The majority of the North Pacific disturbances passed eastward with their centers north of the Aleutian Islands, instead of south of these islands as in January and February. A number of anticyclones moved southeastward or southward over central Siberia and eventually eastward over China and Japan, two of them crossing the Pacific Ocean.

April (*fig. 6*).—During the winter months the paths of the cyclones and the anticyclones were grouped within comparatively narrow limits. There was little tendency in April toward such grouping, especially over North America, the Atlantic Ocean and Europe. On the contrary the paths of the cyclones were fairly well distributed from Baffin Land, northern Greenland and Spitzbergen southward almost to the Tropics. This was due, no doubt, to the slowing up of the general circulation with the advent of spring and to the blocking effect of stationary or slow-moving anticyclones, especially those that, during the spring months, move southeastward from the Hudson Bay-Baffin Land region. The slowing up of the general circulation in the spring is due to the lessening of the temperature gradient from south to north as the sun advances northward.

The temperature during April averaged considerably above normal over practically the entire United States and southern Canada for the third successive month. This was undoubtedly due to the almost entire absence of cyclones over the extreme southern part of the United States. Unless cyclonic conditions exist over the far south, the cold polar air of the Canadian anticyclones does not travel southward either fast or far.

STATISTICS OF CYCLONES AND ANTICYCLONES

Statistics of the origin and movement of all cyclones and anticyclones of the Northern Hemisphere during the four months in question will be found in Table 1. Each primary cyclone or anticyclone is designated by a number, 1, 2, 3, etc., its secondaries, if any, by the same number and a single appropriate letter, *a*, *b*, *c*, etc., and other secondaries that develop, not in connection with the primary cyclone, but in close relation to a secondary, are designated by the number and letter of the originating secondary, together with an additional letter, and so on down the family line until the end. If, for example, the primary cyclone is No. 1, its secondaries are 1a, 1b, 1c, etc.; secondaries of 1a, 1b, 1c, etc., are 1aa, 1ba, 1ca, etc.; and further secondaries of 1aa, etc., are 1aaa, 1baa, 1caa, etc. In case 1aa gives rise to two or more secondaries, they are identified by 1aaa, 1aab, 1aac, etc. In an extreme case in the table one of the secondary anticyclones is No. 3aabaaaab, indicating an extremely long family line covering a great expanse of territory and several weeks of time. In the tabulation the cyclones and anticyclones are separated into principal areas of development, such as the western Pacific Ocean, North America, etc., and the primaries are tabulated by months, although the family line often extends well into the ensuing month. Each cyclone and anticyclone is given a number, arbitrarily designating the one originating nearest the eastern Asiatic coast as No. 1, irrespective of the date of development during the month. Then follows the longitude and latitude of origin, and ending in degrees of longitude and latitude covered during its life with respect to the place of origin, the length of life of each primary, followed by the same data for any secondaries that may develop, and, in addition, in the last column is given the location of the place of development of each secondary with respect to the place of dissipation of its primary cyclone or anticyclone (whether primary or secondary). If any similar attempt to tabulate data of the life histories of cyclones and anticyclones by families and to segregate them into principal areas of development has been made the author is not aware of it.

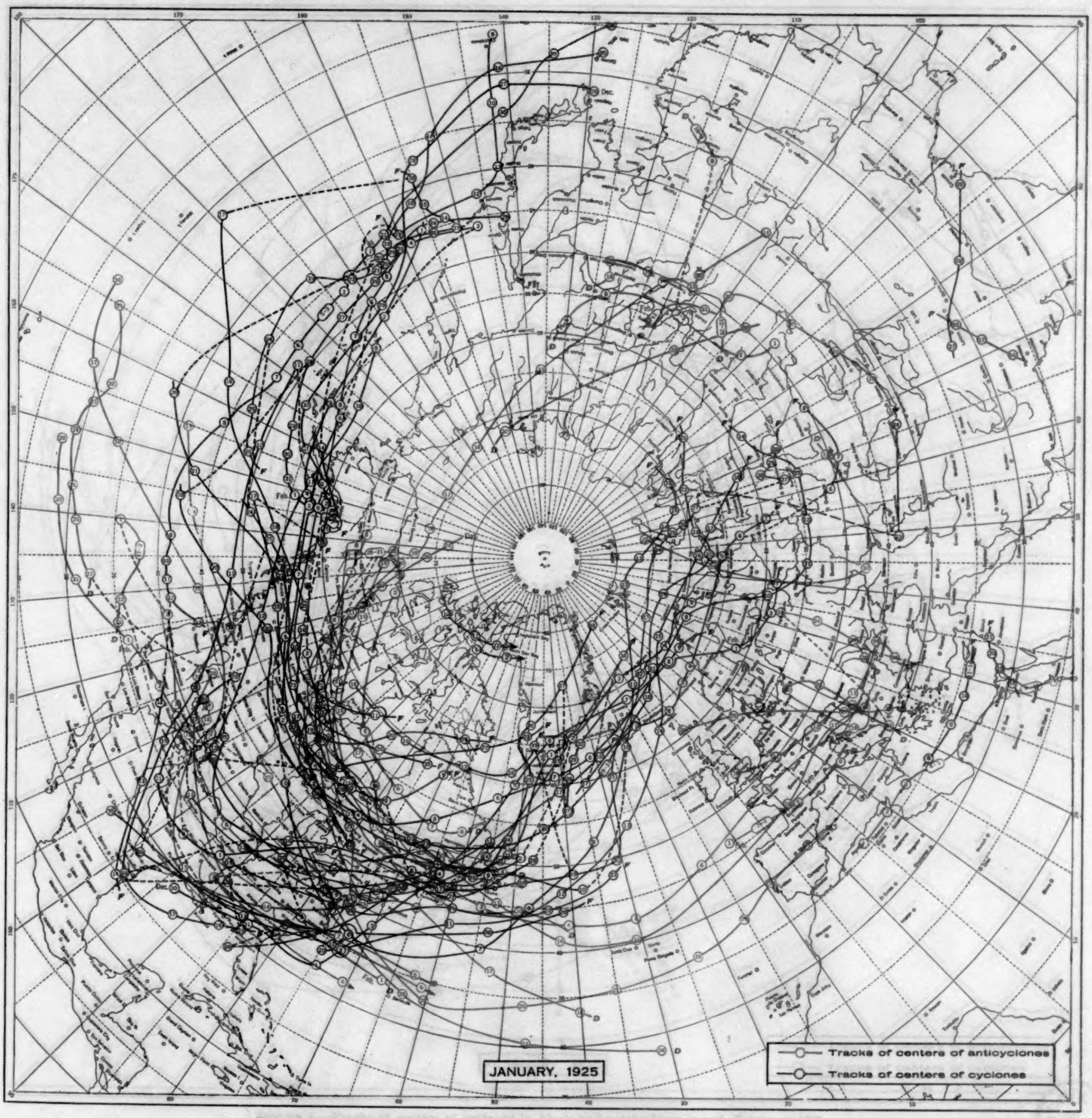

FIGURE 3.—Tracks of centers of cyclones in black and anticyclones in red, January, 1925

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mate, the tables were extended to include all cyclones and anticyclones of consequence of the entire hemisphere.

The paths of all cyclones and anticyclones and the location of the centers each 24 hours, as well as the approximate location of the place of dissipation or disintegration, were carefully plotted for the months of January, February, March, and April, 1929. [illegible] the complete tracks of all cyclones and anticyclones that were in existence during any part of a month appear on the chart for that month. [illegible] there is overlapping in cases where the [illegible] began in the previous month or continued into the next month.

PATHS OF CYCLONES AND ANTICYCLONES BY MONTHS

January, 1929 (fig. 2).—The outstanding features during the month were the almost constant succession of cyclones [illegible] North Pacific Ocean [illegible] Columbia, and from the [illegible] northward over [illegible] [illegible]

[illegible]

[illegible] cyclones passed over the British Isles [illegible] the North Pacific disturbances passed eastward with their centers north of the Aleutian Islands, instead of south of these islands as in January and February. A number of anticyclones moved southeastward or southward over central Siberia and eventually eastward over China and Japan, two of them crossing the Pacific Ocean.

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The temperature during April averaged considerably above normal over practically the entire United States and [illegible] for the third successive month. [illegible] due to the almost entire absence of cyclones over the extreme southern part of the United States. [illegible] conditions exist over the far north, the [illegible] of the Canadian anticyclones [illegible]

[illegible] OF CYCLONES AND ANTICYCLONES

[illegible] of all cyclones and anticyclones of the [illegible] hemisphere during the [illegible] in Table 1. Each [illegible] designated by a number [illegible] by the same [illegible]

[illegible]

[illegible] North [illegible] tabulated by months, [illegible] well into the ensuing month. [illegible] anticyclone is given a number [illegible] the one originating nearest the [illegible] irrespective of the date of development [illegible] Then follows the longitude and latitude [illegible] extending in degrees of longitude and latitude [illegible] its life [illegible] respect to the place of origin, the length of life of each primary, followed by [illegible] secondaries that may develop, and, in addition, in the last column is given the location of the place of development of each secondary with respect to the place of dissipation of its primary cyclone or anticyclone (whether primary or secondary). If any similar attempt to tabulate data of the life histories of cyclones and anticyclones by families and to segregate them into principal areas of development has been made the author is not aware of it.

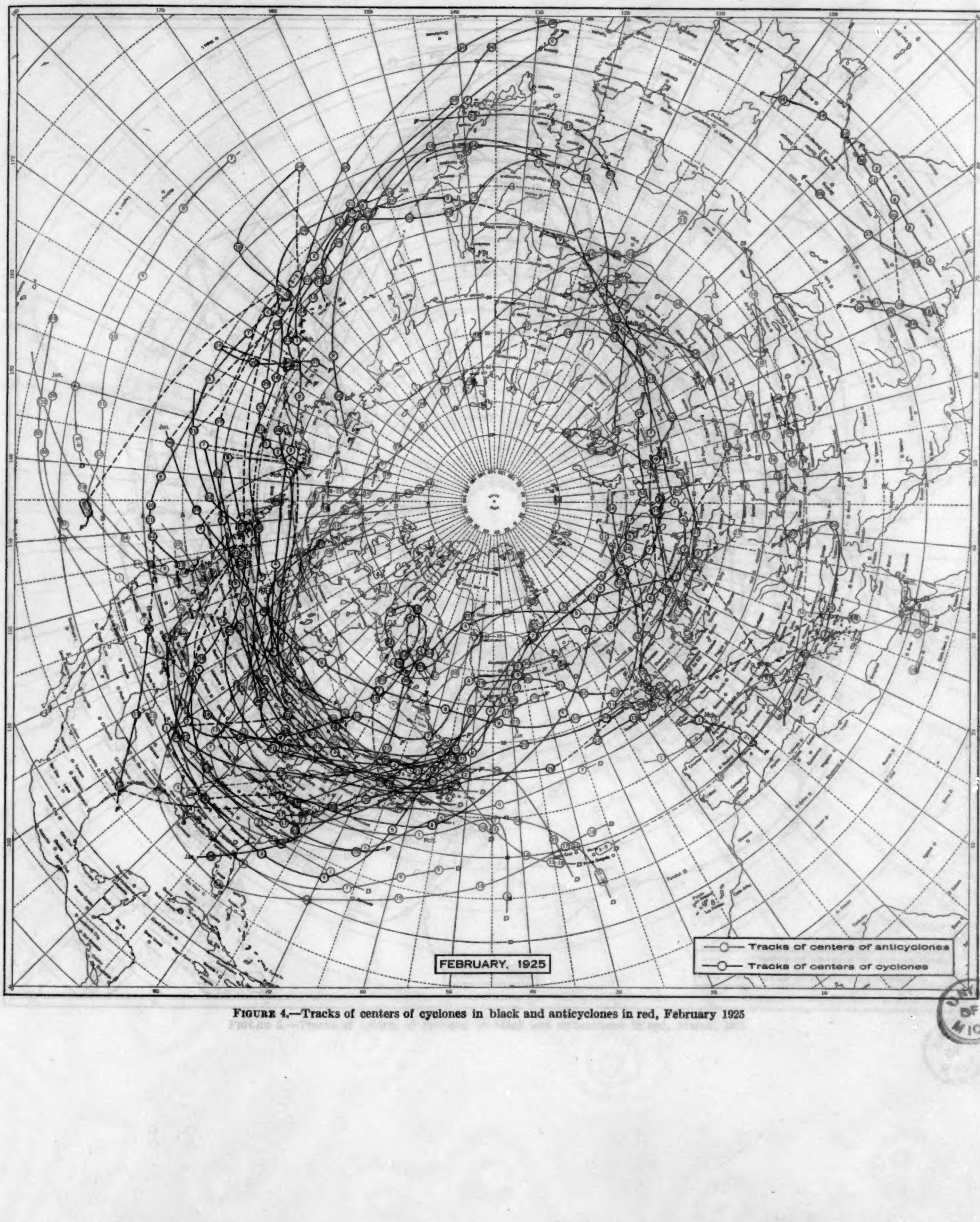

FIGURE 4.—Tracks of centers of cyclones in black and anticyclones in red, February 1925

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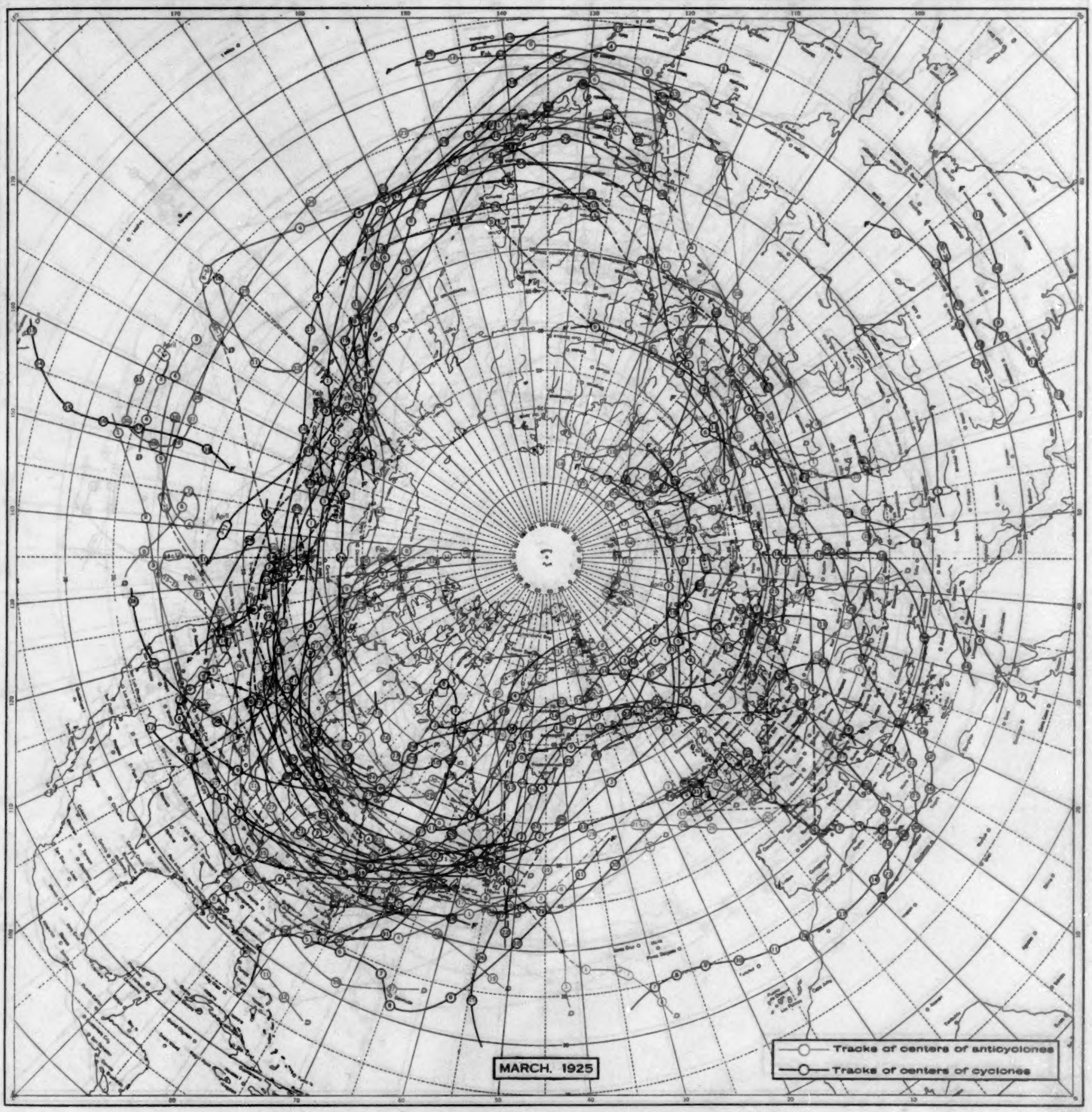

Figure 5.—Tracks of centers of cyclones in black and anticyclones in red, March, 1925

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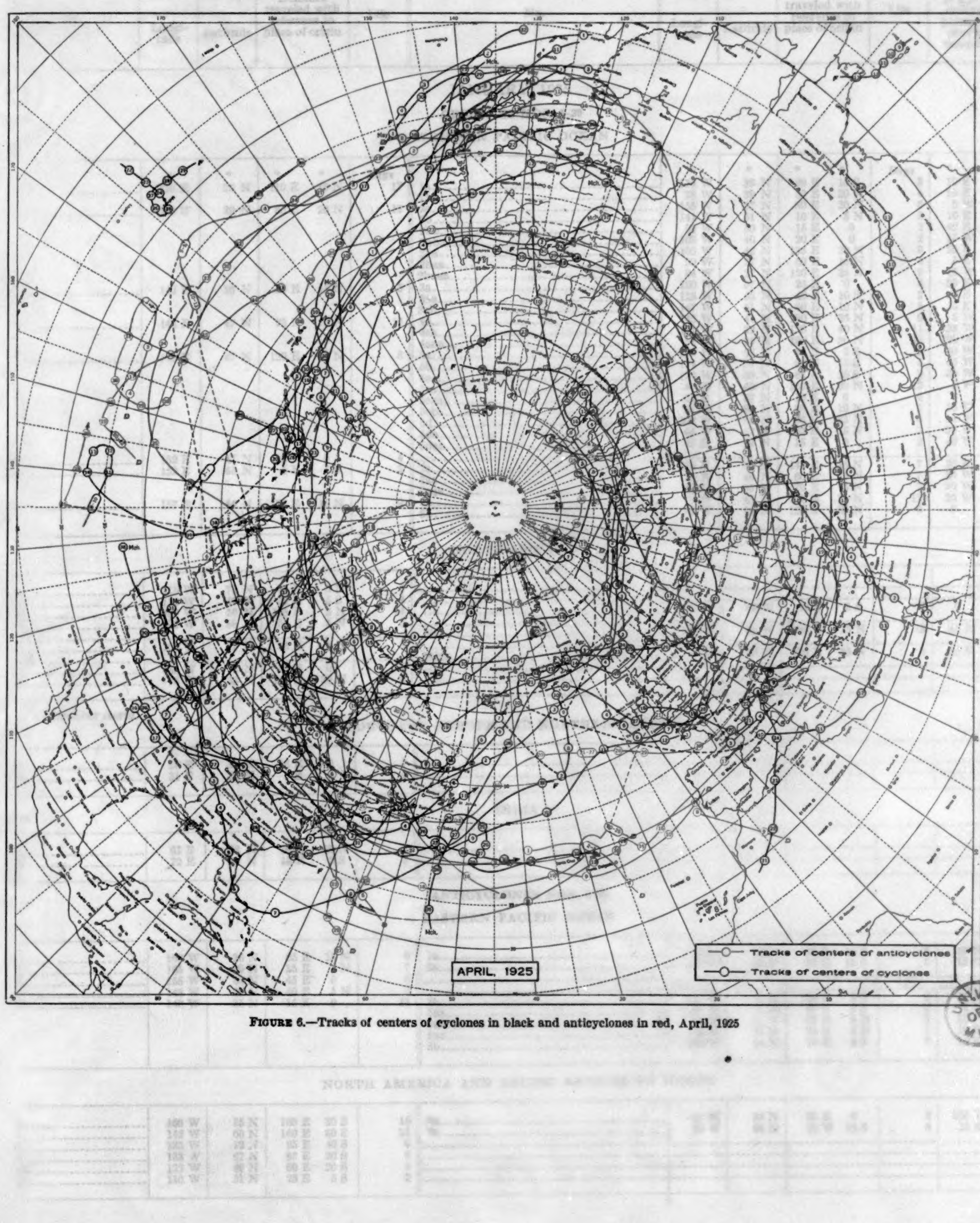

Figure 6.—Tracks of centers of cyclones in black and anticyclones in red, April, 1925

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TABLE 1.—*Life history of cyclones and anticyclones*

JANUARY, 1925

CYCLONES NOS. 1-20

WESTERN PACIFIC OCEAN

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
1	128 E	25 N	110 E	15 N	17	1a	114 W	38 N	20 E	10 S	3	10 E	5 S
						1aa	78 W	38 N	50 E	20 N	4	15 E	10 N
2	128 E	29 N	80 E	20 N	12	2a	158 W	37 N	80 E	20 N	6	5 W	10 S
						2b	141 W	51 N	10 E	5 N	3	10 E	0
						2bb	99 W	50 N	15 E	0	2	40 E	0
						2bba	103 W	40 N	20 E	0	2	15 W	5 S
						2ba	105 W	42 N	135 E	20 N	9	25 E	10 S
						2baa	99 W	27 N	60 E	15 N	4	5 E	15 S
						2baaa	84 W	27 N	120 E	35 N	9	45 W	15 S
3	142 E	26 N	20 E	15 N	5	3a	160 W	57 N	25 E	0	4	35 E	15 N
						3aa	118 W	55 N	40 E	10 S	3	40 E	0
						3ab	147 W	51 N	80 E	10 N	5	15 E	5 S
4	143 E	47 N	75 E	15 N	16	4a	145 W	41 N	180 E	25 N	9	5 W	20 S
						4aa	101 W	32 N	120 E	40 N	11	135 W	30 S
						4aaa	81 W	35 N	195 E	30 N	12	100 W	40 S
5	148 E	47 N	120 E	15 N	8	5a	170 W	58 N	65 E	5 S	3	80 W	0
						5b	174 E	54 N	85 E	15 S	5	95 W	5 S
						5c	170 W	50 N	85 E	20 S	9	80 W	10 S
						5ca	87 W	40 N	150 E	30 N	12	5 W	10 N
						5caa	62 E	57 N	10 E	0	4	0	10 S
						5cb	91 W	34 N	60 E	10 N	5	10 W	5 N
						5d	102 W	36 N	90 E	35 N	6	10 W	25 S
						5da	44 W	52 N	135 E	15 N	7	35 W	20 S
						5daa	47 E	42 N	15 E	0	2	40 W	20 S
6	152 E	47 N	15 E	0	4								
7	152 E	44 N	5 E	5 S	3	7a	179 E	32 N	140 E	35 N	7	20 E	10 S
						7aa	70 W	48 N	60 E	25 N	7	30 W	20 S
						7aaa	42 W	55 N	70 E	5 N	7	30 W	25 S
8	157 E	44 N	135 E	10 N	9	8a	94 W	45 N	175 E	25 N	12	25 W	10 S
						8b	69 W	44 N	160 E	20 N	9	0	10 S

NORTH AMERICA

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
9	115 W	74 N	45 E	5 N	3								
10	112 W	47 N	30 E	5 S	4								
11	108 W	56 N	165 E	5 N	14	11a	57 E	52 N	20 E	5 S	3	0	5 S
12	102 W	58 N	55 E	5 N	5								
13 [1]						13a	103 W	48 N	185 E	15 N	13	45 E	10 S
14	106 W	27 N	35 E	5 N	3								
14½ [1]						14½a	93 W	29 N	110 E	35 N	6	10 E	5 S
15	85 W	73 N	20 E	0	2								
16	76 W	33 N	145 E	30 N	9								

[1] December storm.

SOUTHERN EUROPE AND NORTHERN AFRICA

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
17	18 E	35 N	15 E	0	7								
18	31 E	30 N	5 E	0	4								

INDIA

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
19	67 E	23 N	10 E	10 N	3								
20	72 E	30 N	15 E	5 S	3								

ANTICYCLONES NOS. 1-22

EASTERN PACIFIC OCEAN

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
1	168 W	26 N	65 E	15 N	9	1a	95 W	43 N	65 E	15 S	5	10 E	0
2	165 W	29 N	35 E	5 N	7	2a	115 W	43 N	55 E	15 S	5	15 E	10 N
3	155 W	40 N	45 E	0	6								
4	148 W	28 N	40 E	5 N	7								
5	140 W	35 N	15 E	0	13	5a	127 W	41 N	20 E	5 S	8	15 E	5 N
						5aa	99 W	33 N	45 E	5 S	3	5 E	5 S
						5ab	89 W	31 N	30 E	5 N	3	15 E	5 S
						5ac	95 W	37 N	35 E	5 N	3	10 E	0
						5b	108 W	35 N	70 E	5 S	7	15 E	0

NORTH AMERICA AND ARCTIC REGIONS TO NORTH

Primary No.	Primary Origin Longitude	Primary Origin Latitude	Primary Distance traveled with reference to place of origin		Primary Life	Secondary No.	Secondary Origin Longitude	Secondary Origin Latitude	Secondary Distance traveled with reference to place of origin		Secondary Life	Beginning, with reference to place of ending of primary or previous secondary	
6	150 W	75 N	165 E	30 S	16	6a	92 W	33 N	20 E	0	3	105 W	15 S
7	142 W	66 N	160 E	30 S	18	7a	29 W	58 N	10 W	10 S	4	10 E	25 N
8	135 W	72 N	95 E	40 S	9								
9	133 W	67 N	85 E	20 S	8								
10	122 W	69 N	60 E	20 S	6								
11	110 W	51 N	25 E	5 S	2								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin		Distance traveled with reference to place of origin		Life	No.	Origin		Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	
	Longitude	Latitude					Longitude	Latitude					
JANUARY, 1925—Continued													
ANTICYCLONES NOS. 1-22—Continued													
EUROPE AND NORTHERN AFRICA													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
12	2 W	51 N	35 E	10 S	7								
13	2 W	61 N	25 E	20 S	6								
14	5 E	43 N	10 E	5 S	2								
15	5 E	35 N	25 E	10 S	13								
16	29 E	25 N	5 E	10 S	4								
NOVA ZEMBLA REGION													
17	58 E	76 N	40 E	20 S	4								
SIBERIA													
18	70 E	42 N	0	10 N	9								
19	90 E	51 N	45 E	10 N	11	19a	113 E	35 N	5 E	5 S	3	20 W	25 S
20	95 E	51 N	80 E	25 N	3								
21	102 E	41 N	220 E	10 N	25	21a	105 W	54 N	110 E	15 S	10	65 W	5 N
						21aa	8 W	45 N	10 E	0	5	15 W	5 N
						21b	110 W	53 N	70 E	15 S	6	70 W	5 N
						21c	95 W	32 N	45 E	5 N	7	55 W	20 S
22	115 E	50 N	10 E	5 N	3								
FEBRUARY, 1925													
CYCLONES NOS. 1-13													
WESTERN PACIFIC OCEAN AND ASIATIC COAST													
1	127 E	24 N	205 E	40 N	12	1a	116 W	43 N	120 E	30 N	12	85 W	20 S
						1aa	96 W	37 N	75 E	30 N	6	100 W	40 S
						1aaa	7 E	53 N	10 E	5 S	2	25 E	10 S
2	127 E	28 N	75 E	40 N	5								
3	115 E	40 N	30 E	5 S	3								
4	130 E	42 N	50 E	10 N	6	4a	166 E	36 N	20 E	10 N	7	15 W	15 S
						4aa	151 W	48 N	30 E	0	3	25 E	0
						4aaa	113 W	39 N	115 E	0	12	5 E	10 S
						4aaaa	76 W	37 N	15 E	0	2	80 W	5 S
						4ab	148 W	44 N	20 E	10 N	3	25 E	5 S
						4aba [2]	104 W	48 N	405 E	0	29	25 E	5 S
						4abaa	70 E	64 N	60 E	5 S	3	230 W	15 N
						4abaaa	145 E	47 N	35 E	10 N	3	15 E	15 S
						4abaaaa	126 E	42 N	40 E	5 N	3	50 W	15 S
						4abab	6 E	55 N	35 E	10 N	8	295 W	10 N
						4ac	134 W	33 N	5 E	0	3	45 E	10 S
						4ad	122 W	53 N	125 E	15 S	13	55 E	20 N
						4ada	28 E	34 N	10 E	15 N	3	25 E	5 S
						4adb	20 E	52 N	75 E	10 N	5	15 W	5 N
						4adc	29 E	56 N	50 E	5 N	4	20 E	15 N
5	140 E	42 N	5 E	0	1								
6 [3]						6a [4]							
						6b	130 W	47 N	180 E	30 N	11	10 E	15 S
						6ba	20 W	53 N	70 E	5 N	8	70 W	20 S
						6baa	24 E	68 N	45 E	5 S	4	25 W	10 N
						6bab	15 E	56 N	85 E	0	10	35 W	5 S
						6baba	8 E	39 N	10 E	0	2	80 W	15 S
						6babb	126 E	45 N	70 E	20 N	6	25 E	10 S
						6babba	132 W	52 N	10 E	10 S	3	35 E	10 S
						6bb	60 E	55 N	135 E	5 N	12	10 E	20 S
						6bba	164 W	44 N	10 W	15 N	4	0	15 S
						6bbaa	152 W	56 N	70 E	10 S	5	20 E	5 S
						6bbab	110 W	51 N	60 E	10 N	6	65 E	10 S
						6c	102 W	53 N	30 E	5 S	2	40 E	10 S
						6d	145 W	50 N	30 E	50 N	3	5 W	10 S
						6da	102 W	41 N	35 E	10 N	5	15 E	15 S
						6e	145 W	47 N	30 E	0	3	0	15 S
						6ea	105 W	39 N	50 E	15 N	6	10 E	10 S
						6eaa	76 W	56 N	5 E	5 N	6	20 W	0
NORTH AMERICA													
7	121 W	62 N	35 E	10 S	3	7a	111 W	47 N	105 E	10 N	10	25 W	5 S
8	98 W	39 N	95 E	15 N	6								
9	77 W	58 N	20 E	15 N	3								
INDIA													
10	68 E	28 N	5 E	10 N	3								
11	68 E	23 N	5 E	5 N	3	11a	82 E	25 N	20 E	0	6	10 E	5 S
12	75 E	26 N	15 E	5 N	3								
13	75 E	22 N	10 E	5 N	4								

[2] Around-the-world storm. [3] January cyclone No. 4. [4] January secondary No. 4a.

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°

FEBRUARY, 1925—Continued

ANTICYCLONES NOS. 1-15

PACIFIC OCEAN

1	163 E	30 N	90 E	10 N	13								
2	158 E	25 N	75 E	5 N	6								
3	151 W	30 N	10 E	5 N	3	3a	123 W	42 N	100 E	0	10	20 E	5 N
4	147 W	26 N	30 E	15 N	4	4a	128 W	45 N	25 E	10 S	4	10 W	0

NORTH AMERICA AND ARCTIC REGIONS TO NORTH

5	155 W	80 N	110 E	35 S	12	5a	121 W	60 N	95 E	30 S	15	75 W	15 N
6	132 W	67 N	90 E	30 S	9	6a	76 W	50 N	40 E	15 S	4	35 W	15 N
						6aa	65 W	58 N	45 E	15 N	4	30 W	25 N
						6b	15 W	55 N	10 E	5 S	3	25 E	20 N
7	123 W	68 N	100 E	20 S	9	7a	55 W	61 N	40 E	10 S	6	30 W	10 N
						7aa	12 E	78 N	90 E	5 S	11	25 E	30 N
						7aaa	5 W	65 N	10 E	25 S	4	105 W	10 S
						7aaaa	20 W	52 N	20 E	0	5	25 W	10 N
						7aaaaa	13 E	50 N	50 E	0	9	15 E	5 S
						7aab	75 E	60 N	25 E	10 S	7	25 W	15 S
						7aaba	120 E	34 N	25 E	5 N	3	20 E	15 S
						7b	85 W	37 N	15 E	10 S	7	60 W	15 S
8	100 W	62 N	65 E	25 S	9								
9	97 W	54 N	45 E	10 S	3								
10	80 W	62 N	65 E	0	5								

EASTERN ATLANTIC OCEAN

11	28 W	38 N	5 E	0	6	11a	5 W	40 N	30 E	10 S	5	15 E	5 N
						11aa	52 E	42 N	10 E	0	2	25 E	15 N
						11aaa	43 E	47 N	50 E	5 S	7	20 W	5 N
						11aaaa	52 E	46 N	40 E	5 N	6	40 W	5 N

EUROPE

12	13 E	59 N	40 E	10 S	8								
13	22 E	28 N	10 E	5 N	6								

LIBERIA

14	73 E	51 N	70 E	25 N	7								
15	105 E	52 N	10 E	5 N	3	15a	75 E	53 N	30 E	0	9	40 W	0
						15aa	158 E	72 N	110 E	25 S	7	50 E	15 N

MARCH, 1925

CYCLONES NOS. 1-29

WESTERN PACIFIC OCEAN AND ASIATIC COAST

1	115 E	26 N	75 E	40 N	5								
2	117 E	42 N	115 E	15 N	8								
3	121 E	39 N	50 E	5 N	4								
4	124 E	37 N	80 E	30 N	8	4a	173 E	51 N	45 E	5 S	6	30 W	10 S
						4aa	122 W	41 N	50 E	5 S	9	20 E	5 S
						4b	138 W	51 N	20 E	10 S	3	15 E	10 S
5	126 E	25 N	25 E	0	3								
6	138 E	32 N	280 E	45 N	22	6a	118 W	52 N	40 E	5 N	4	170 W	25 S
						6b	146 W	56 N	35 E	10 S	4	200 W	20 S
						6c	75 W	42 N	10 E	0	3	135 W	35 S
						6ca	73 W	35 N	125 E	35 N	8	5 W	10 S
						6caa	76 W	37 N	30 E	25 N	6	125 W	35 S
						6 cab	17 W	56 N	15 E	10 S	4	65 W	15 S
						6caba	9 E	45 N	40 E	0	6	0 E	5 S
						6 caaa	29 W	50 N	5 E	10 N	4	15 E	10 S
						6 caaaa	15 E	75 N	135 E	5 S	12	35 E	15 N
						6 caaaaa	90 E	59 N	110 E	10 N	11	60 W	10 S
						6d	3 E	44 N	5 E	0	2	55 W	35 S

HAWAIIAN ISLANDS

7	143 E	36 N	40 E	20 N	3								
8	159 W	21 N	10 E	25 N	4								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin		Distance traveled with reference to place of origin		Life	No.	Origin		Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	
	Longitude	Latitude					Longitude	Latitude					
MARCH, 1925—Continued													
CYCLONES NOS. 1-29—Continued													
NORTH AMERICA													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
9	143 W	53 N	60 E	0	5	9a	107 W	36 N	105 E	15 N	9	20 W	15 S
						9aa	52 W	41 N	55 E	25 N	8	50 W	10 S
10	130 W	37 N	25 E	5 N	3	10a	118 W	40 N	115 E	5 N	13	15 W	0
11	111 W	53 N	25 E	5 S	2								
12	112 W	35 N	200 E	35 N	14								
12	94 W	60 N	65 E	15 N	5								
14	78 W	33 N	45 E	20 N	7								
15	75 W	34 N	15 E	10 N	3								
ATLANTIC OCEAN													
16	55 W	33 N	55 E	20 N	7	16a	42 W	55 N	160 E	20 N	7	40 W	0
						16aa	1 W	66 N	80 E	5 N	4	120 W	10 S
17	32 W	34 N	60 E	5 N	13								
SOUTHERN EUROPE AND NORTHERN AFRICA													
18	6 W	73 N	30 E	10 S	3								
19	0	32 N	100 E	20 N	12								
20	3 E	33 N	30 E	30 N	8								
21	17 E	38 N	30 E	20 N	6								
22	16 E	45 N	30 E	20 N	7								
23	33 E	28 N	10 E	5 N	2								
24	36 E	35 N	45 E	20 N	6	24a	127 E	43 N	30 E	0	2	40 E	5 S
CASPIAN SEA REGION													
25	54 E	39 N	10 E	0	1								
INDIA													
26	62 E	22 N	10 E	10 N	3								
27	68 E	31 N	15 E	0 N	7								
28	71 E	28 N	20 E	5 N	4								
29	74 E	25 N	15 E	0	3								
ANTICYCLONES NOS. 1-20													
EASTERN PACIFIC OCEAN													
1	175 h	35 N	5 E	15 N	3								
2	168 W	38 N	35 E	0	7								
3	155 W	39 N	65 E	5 S	11	3a	126 W	45 N	20 E	5 S	3	35 W	15 N
						3aa	95 W	48 N	10 E	0	4	10 E	10 N
						3aaa	70 W	57 N	15 E	0	4	15 E	10 N
						3aab	40 W	41 N	15 E	5 S	4	45 E	10 S
						3aaba	12 W	50 N	90 E	5 N	13	10 E	15 N
						3aabaa	50 W	60 N	65 E	5 S	6	25 W	5 N
						3aabaaa	117 E	35 N	25 E	5 N	8	0	15 S
						3aabaaaa	165 E	39 N	95 E	0	9	25 E	5 S
						3aabaaaaa	104 W	45 N	30 E	20 N	5	5 W	5 N
						3aabaaaab	135 W	30 N	10 W	0	3	35 W	10 S
4	152 W	33 N	35 E	5 N	4								
NORTH AMERICA AND ARCTIC REGIONS TO NORTH													
5	138 W	71 N	85 E	35 S	8	5a	137 W	53 N	125 E	25 N	25	85 W	20 N
6	130 W	68 N	80 E	20 S	4	6a	97 W	53 N	45 E	10 S	4	50 W	5 N
7	135 W	80 N	20 E	20 S	5	7a	122 W	62 N	155 E	15 S	20	5 W	0
8	120 W	70 N	75 E	30 S	8	8a	80 W	33 N	20 E	0	3	35 W	20 S
9	113 W	56 N	90 E	20 N	5								
10	75 W	74 N	65 E	0	5								
NORTHERN EUROPE													
11	28 E	63 N	15 E	20 S	4								
NOVA ZEMBLA REGION													
12	53 E	66 N	135 E	25 S	20	12a	132 W	54 N	20 E	5 N	2	35 E	10 N
						12b	126 W	48 N	5 E	5 N	1	40 E	5 N
13	60 E	73 N	70 E	45 S	7								
14	85 E	76 N	10 E	20 S	12	14a	141 E	38 N	10 E	0	2	45 E	15 S
15	84 E	73 N	55 E	45 S	7								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Beginning, with reference to place of ending of primary or previous secondary	
MARCH, 1925—Continued													
ANTICYCLONES NOS. 1-20—Continued													
SIBERIA													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
16	59 E	47 N	10 E	10 N	3								
17	63 E	52 N	5 E	0	1								
18	70 E	50 N	45 E	0	5								
COAST OF CHINA													
19	118 E	32 N	30 E	0	3								
20	125 E	37 N	85 E	0	15	20a	175 W	60 N	45 E	5 N	3	25 W	25 N
APRIL, 1925													
CYCLONES NOS. 1-27													
WESTERN PACIFIC OCEAN AND ASIATIC COAST													
1	124 E	26 N	25 E	5 N	4								
2	123 E	29 N	20 E	5 N	3								
3	127 E	29 N	85 E	30 N	7	3a	117 W	62 N	15 E	0	2	35 E	5 N
						3aa	59 W	57 N	150 E	5 S	12	40 E	5 S
						3b	132 W	48 N	20 E	0	2	20 E	10 S
						3ba	116 W	40 N	55 E	35 N	9	5 W	10 S
						3baa	110 W	42 N	50 E	35 N	6	50 W	35 S
						3baaa	83 W	50 N	45 E	10 S	5	25 W	25 S
						3baab	23 W	60 N	45 E	5 S	5	35 E	15 S
4	128 E	26 N	70 E	40 N	6								
5	121 E	36 N	15 E	5 N	4								
6	115 E	39 N	80 E	20 N	7								
7	114 E	46 N	100 E	20 N	10	7a	134 W	33 N	5 E	25 N	9	10 E	30 S
						7aa	112 W	56 N	15 E	10 S	2	20 E	5 S
						7aaa	105 W	41 N	80 E	0	14	5 W	5 S
						7b	106 W	55 N	60 E	5 S	4	40 E	10 S
8	133 E	26 N	15 E	15 N	4								
9	134 E	32 N	15 E	10 N	4								
MIDWAY ISLAND													
10	177 W	22 N	5 W	5 N	8								
NORTH AMERICA													
11	155 W	51 N	5 E	5 N	5								
12	116 W	53 N	55 E	15 N	4	12a	74 W	47 N	60 E	25 N	4	15 W	20 S
						12b	88 W	62 N	75 E	10 N	4	30 W	5 S
13	113 W	68 N	60 E	15 S	4								
14	109 W	66 N	260 E	0	20	14a	13 E	47 N	20 E	0	4	135 W	20 S
						14b	8 W	53 N	15 E	5 S	4	160 W	10 S
						14c	4 E	41 N	40 E	0	5	145 W	25 S
						14d	30 E	58 N	100 E	5 S	11	120 W	5 S
15	107 W	32 N	5 E	0	2								
16	106 W	35 N	35 E	0	4								
17	96 W	56 N	60 E	5 S	5								
18	92 W	64 N	295 E	5 S	16								
NORTHERN AFRICA													
19	7 W	29 N	30 E	15 N	8								
20	26 E	28 N	10 E	0	2								
21	34 E	33 N	0	20 N	9								
BLACK AND CASPIAN SEA REGION													
22	34 E	42 N	25 E	0	2								
23	45 E	40 N	75 E	15 N	8								
24	50 E	38 N	20 E	5 N	3								
INDIA													
25	65 E	29 N	25 E	0	6								
26	69 E	29 N	5 E	0	6								
27	95 E	13 N	5 E	5 N	5								
ANTICYCLONES NOS. 1-18													
COAST OF CHINA													
1	114 E	32 N	15 E	0	3								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	
APRIL, 1925—Continued													
ANTICYCLONES NOS. 1-18—Continued													
PACIFIC OCEAN													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
2	165 E	35 N	10 E	0	2								
3	170 W	46 N	35 E	10 S	10								
NORTH AMERICA AND ARCTIC REGIONS TO NORTH													
4	132 W	67 N	35 E	25 S	4								
5	121 W	67 N	115 E	35 S	11	5a	65 W	35 N	10 E	0	1	60 W	5 S
6	95 W	75 N	20 E	0	2								
7	101 W	70 N	35 E	35 S	6								
8	94 W	68 N	5 E	10 S	2								
9	109 W	52 N	85 E	10 S	11	9a	108 W	42 N	25 E	10 S	4	85 W	0
						9b	8 W	52 N	80 E	10 S	9	15 E	10 N
10	100 W	52 N	100 E	10 S	11								
11	99 W	58 N	40 E	35 S	9								
12	92 W	57 N	45 E	25 S	5								
EASTERN ATLANTIC OCEAN													
13	12 W	38 N	10 E	10 S	2								
SPITZBERGEN AND NOVA ZEMBLA													
14	15 E	80 N	30 E	5 S	4								
15	22 E	78 N	0	10 S	2								
16	45 E	73 N	105 E	5 N	6								
EUROPE													
17	26 E	41 N	85 E	10 N	7	17a	130 E	50 N	55 E	5 N	7	20 E	0
18	47 E	52 N	95 E	20 S	15								

Beginnings and endings.—The beginnings and endings of cyclones and anticyclones as given in Table 1 are plotted in Figures 7 to 14, inclusive. These figures are self-explanatory.

Number that developed and dissipated.—Figures 15 to 22, inclusive, show the number of cyclones and anticyclones that developed and dissipated in each 10-degree square in the Northern Hemisphere during the months January to April, inclusive, 1925. Figure 15 shows quite clearly that the principal area of development of primary cyclones is off the eastern coast of Asia, and especially over the water south of Korea and southwest of Japan, with another area of frequent development over and near northwestern India. However, the latter cyclones are of minor intensity, as a rule, throughout their life. Figure 17 shows five areas of principal development of secondary cyclones, as follows:

(1) The northeastern Pacific Ocean south of Cordova, Alaska; (2) a large area of continental North America from Alberta and Saskatchewan southward to the middle Plateau and southern Rocky Mountain regions; (3) from New York southward to the vicinity of Cape Hatteras; (4) south of Greenland; (5) France and the northwestern Mediterranean Sea.

It will be noted that no primary cyclone developed within many hundreds of miles of Greenland and no secondaries, except over a limited area south of the extreme southern point of that place, in spite of the fact that much prominence has been given in recent years to the theory that the air rushing down from the great ice cap of Greenland is responsible for the development of many of the storms of the north Atlantic Ocean. On the other hand, many cyclones dissipated over or near Greenland and Iceland (see fig. 18) and only one other 10-degree square in the Northern Hemisphere, shows a greater number than the square embracing much of southern Greenland.

Little evidence has been found by the writer to indicate that Greenland, with its enormous accumulation of ice, materially affects the development or path of movement of cyclones. Of 17 cyclones that moved into the Greenland-Iceland area during January and February, 1925, there were six that showed their greatest 12-hour increase in intensity before reaching Newfoundland, seven between Newfoundland and Greenland, two with equal amounts of increase in intensity during the 12 hours before reaching Newfoundland and Greenland, respectively, and only two that had the greatest 12-hour increase between Greenland and Iceland.

The principal regions of formation of anticyclones as shown in Figures 19–20, inclusive, are referred to in the discussion on page 13. Figure 22 shows that the regions where anticyclones dissipate or merge with other areas of high pressure are quite well distributed over the

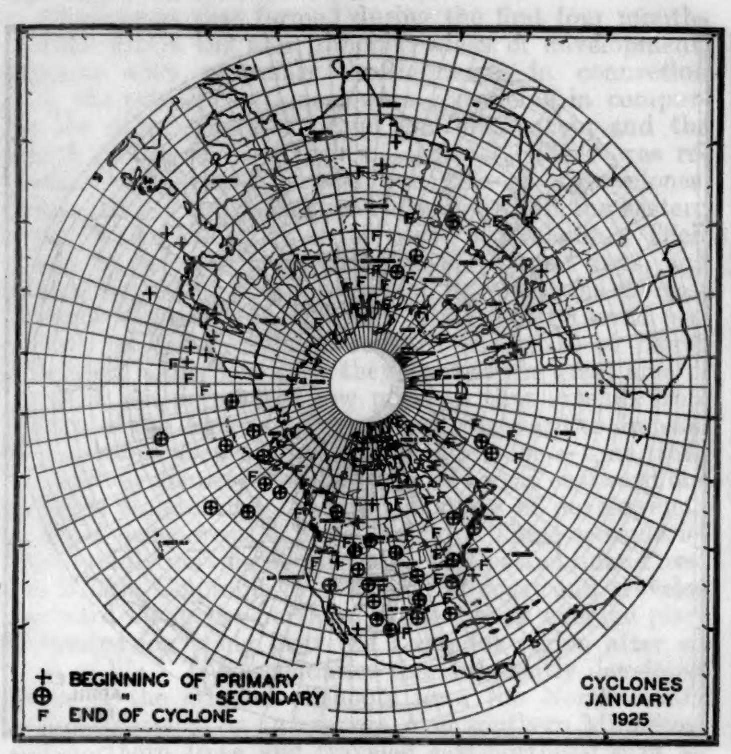


FIGURE 7.—Geographic position of beginnings and endings of cyclones, January, 1925

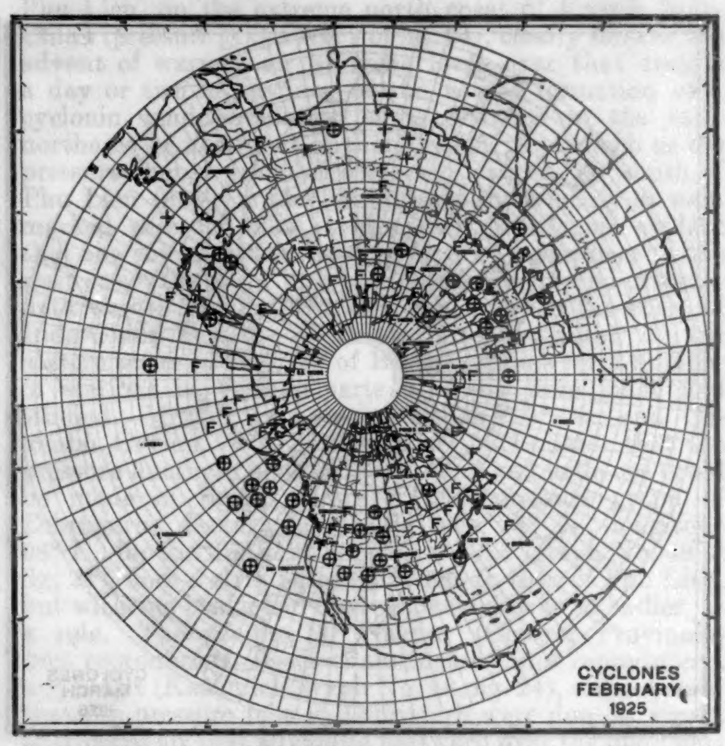


FIGURE 9.—Geographic position of beginnings and endings of cyclones, February, 1925

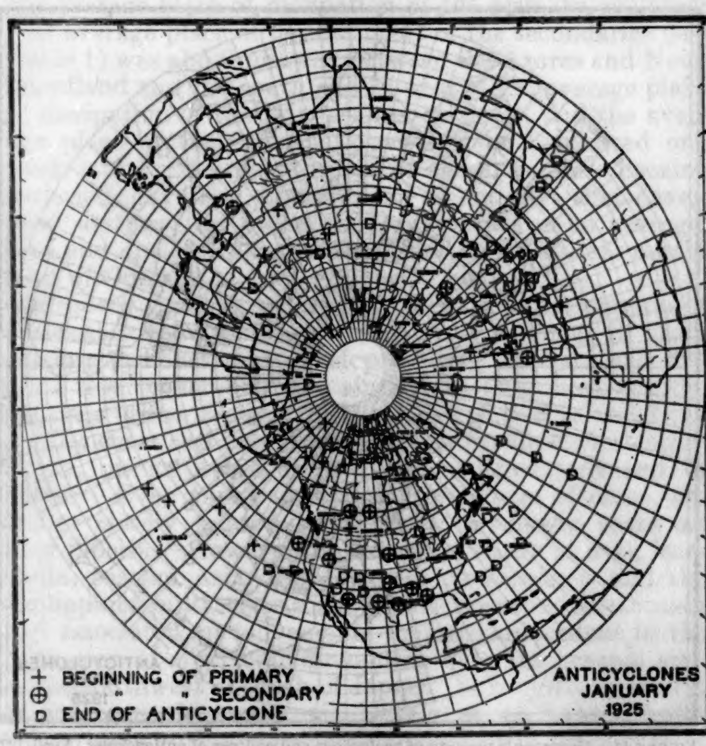


FIGURE 8.—Geographic position of beginnings and endings of anticyclones, January, 1925

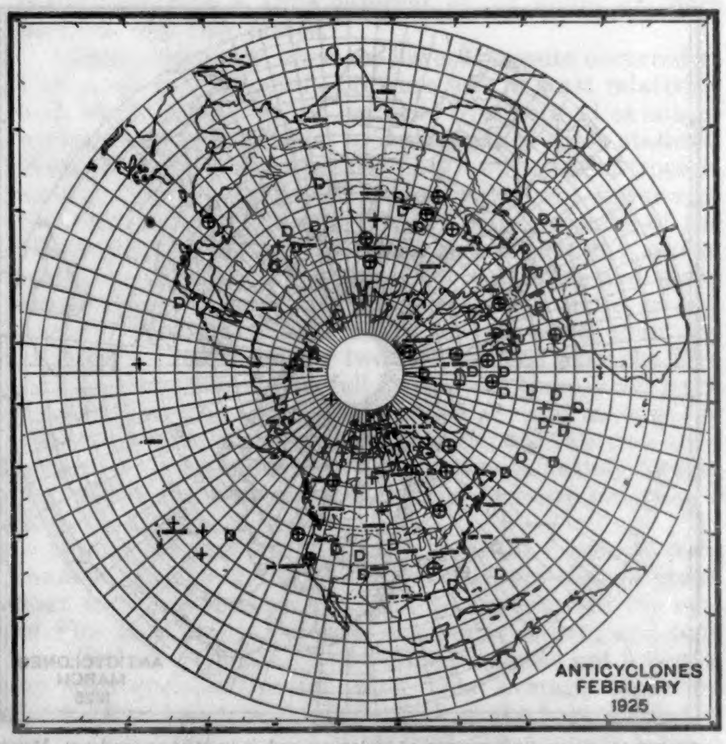


FIGURE 10.—Geographic position of beginnings and endings of anticyclones, February, 1925

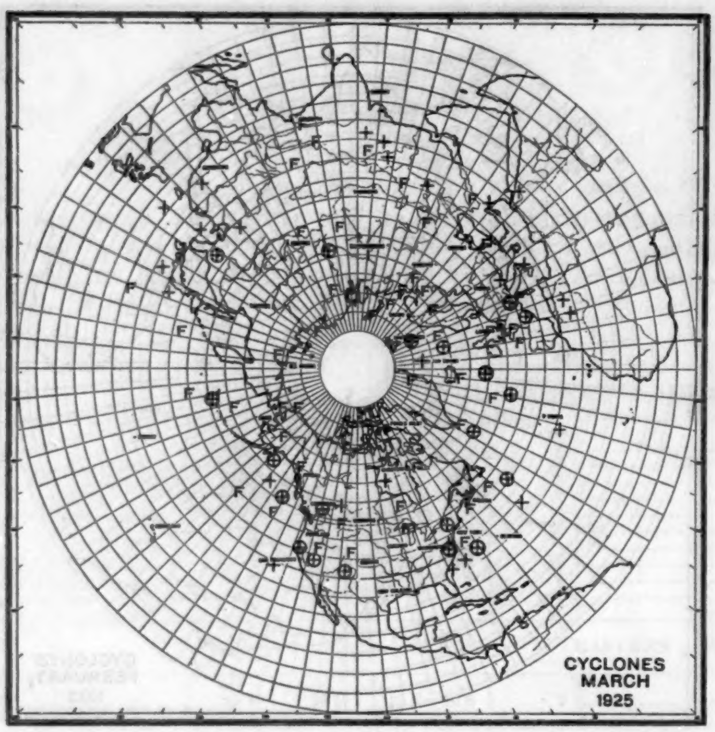


FIGURE 11.—Geographic position of beginnings and endings of cyclones March, 1925

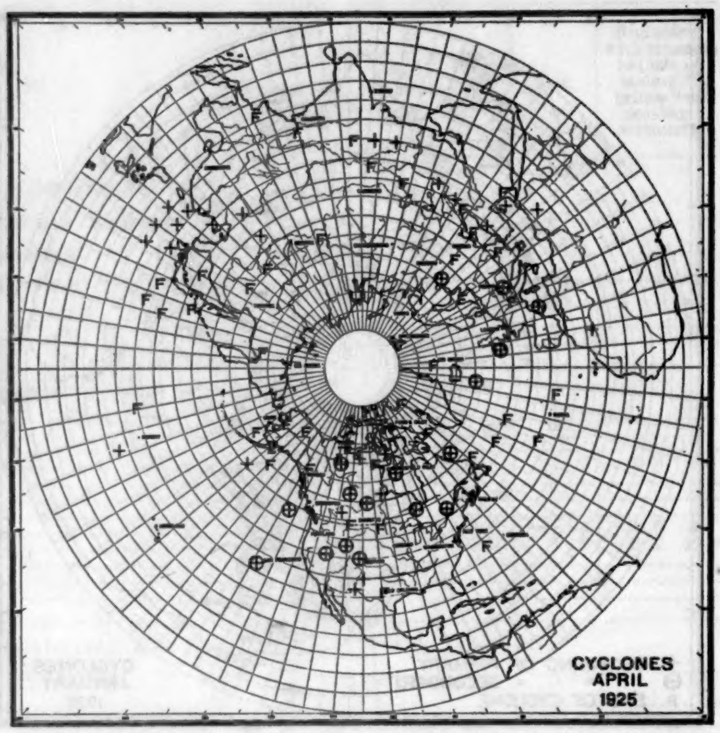


FIGURE 13.—Geographic position of beginnings and endings of cyclones, April, 1925

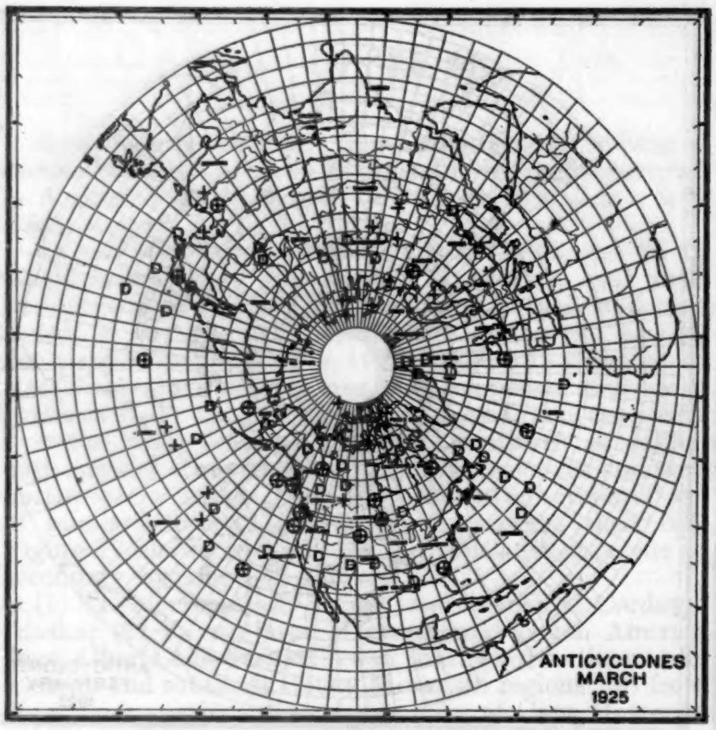


FIGURE 12.—Geographic position of beginnings and endings of anticyclones, March, 1925

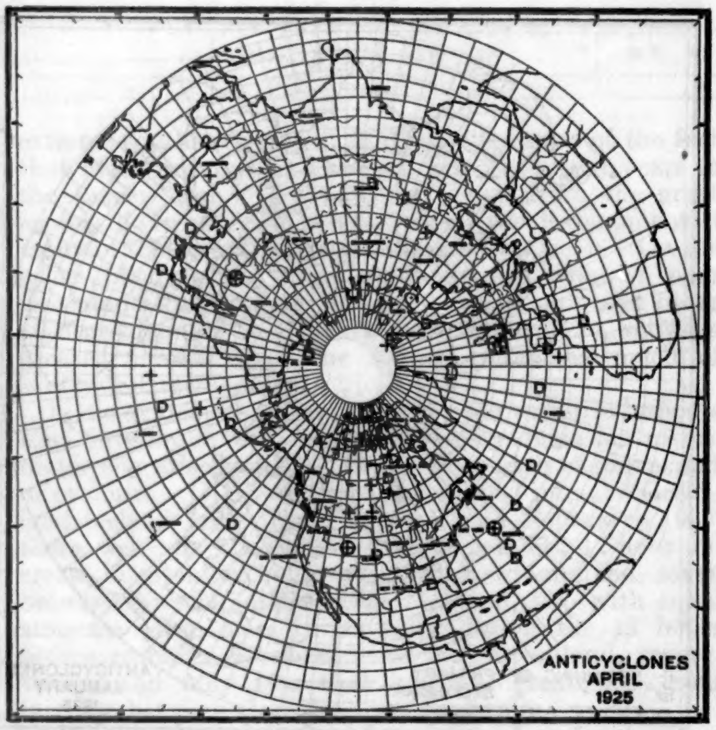


FIGURE 14.—Geographic position of beginnings and endings of anticyclones, April, 1925

Northern Hemisphere north of latitude 30°, with the exception of Greenland and Alaska, and from Russia eastward over northern Siberia.

All cyclones that formed during the first four months of 1925 within the four principal areas of development, together with secondary developments in connection with the primary cyclones, were considered in computing the mean places of origin and dissipation and the length of life of each type of cyclone. There was remarkable uniformity in the behavior of all cyclones, irrespective of the month, that developed off the eastern coast of Asia and south of the island of Sakhalin. Their length of life was greatest in January, nine days, and least in February, four and one-half days, but the shortest distance covered was in April. Only a very small percentage of these cyclones reached the coast of North America. Quite generally they entered the great area of more or less permanent low pressure that extends from the tip of the Aleutian Archipelago, eastward to Juneau, considerably deepening that depression for a time, then losing their identity after sending off to the eastward one or more secondaries, the average place of development of these being west of Puget Sound. These secondaries were rapidly moving disturbances that passed inland over the British Columbia or Washington coast and traveled eastward along the northern border, their average place of dissipation being over the Labrador region after six days of life. The secondaries that frequently developed south of the original offshoots from the North Pacific cyclones formed, on an average, over southern Minnesota and northern Iowa and traveled east-northeastward for six and one-half days, passing south of Greenland and dissipating south of Iceland and west of Ireland. These secondaries usually developed about the time of occlusion of the primary disturbances, and these particular secondaries formed, on an average, 28° west and 12° south of the average place of dissipation of the primary cyclones. The average place of development of the secondaries (see Table 1) was about midway between the Azores and Newfoundland and 10° south and 7° west of the average place of dissipation of the primary 1aa cyclones, and the average place of their dissipation was near Leningrad one week later. Meanwhile most of these, as they became occluded, gave rise to the 1aaaa secondaries that developed southwest of Ireland and dissipated, on an average, four and one-half days later over southern Russia northwest of Odessa.

Primary cyclones, place of origin.—It is the opinion of the author that the only true primary cyclones (if there are any cyclones that develop entirely separate and distinct from other cyclones already in existence) are the cyclones of the western Pacific Ocean that develop off the Asiatic coast and first show a typical cyclonic wind circulation, on an average, near the southwestern end of Japan. Even these, in a small percentage of cases, are rather closely related to cyclones advancing eastward over Siberia. However, an extensive study of data from India, eastern Asia, the Japanese Archipelago, and the Philippines quite clearly shows the pressure distribution and associated air movements that are antecedent to the formation of a cyclonic circulation over the oceanic area to the southwest or south of Japan. It is quite necessary, in the case of extra-tropical cyclones, to have counter air currents with a considerable contrast in temperature, the cold polar air usually moving toward the southwest and the warm tropical air to the east moving toward the northeast. The Siberian anticyclone supplies the polar air that flows southward over China and Japan and later toward the southwest after reaching more southerly latitudes. The question arose as to the source of the warm tropical air needed to complete the requirements for cyclone development. The pressure-change graph of Phu Lien, on the extreme north coast of French Indo-China (pressure graph No. 7 of fig. 24), clearly showed the advent of warmer air at some level over that station a day or two in advance of the actual formation of a cyclonic wind circulation some distance to the east-northeast or northeast of that station. Inasmuch as the pressure change graph of Cape St. Jacques, 11° south of Phu Lien (not reproduced), did not show nearly as well-marked pressure falls as Phu Lien, it became evident that the source of the tropical air was somewhere to the west or southwest of Phu Lien. Inasmuch as no pressure data were available for the region between the coast of Indo-China and the coast of Burmah (India), on the eastern shore of the Bay of Bengal, graphs for a number of stations in various parts of India were made and studied. Mergui, in Lower Burmah, 10° N., and Colombo, Ceylon, 7° N., are so near the Equator that the pressure fluctuations were quite small and little use could be made of them. However, the pressure graph of Dibrugarh, Assam (India), latitude 28° N., longitude 98° E., for the first four months of 1925 (graph No. 49 of fig. 24), bore a striking resemblance to that of Phu Lien, but with the peaks and depressions a day or so earlier, as a rule. The graphs for Nagpur (Central Provinces) (not reproduced), Pasni (Baluchistan) (not reproduced), and Gilgit (Kashmir) (graph No. 48, fig. 24), did not show that the pressure falls at Dibrugarh were due, as a rule, to tropical air that advanced eastward over the main part of India. There was only one other possible source and that was the Bay of Bengal. In order to find further proof that this was the case, a pressure graph for Calcutta (not reproduced) was prepared, and, with minor exceptions, it was almost an exact duplicate of the Dibrugarh graph, allowing a time interval of 12 hours or more between the two places.

Almost invariably when the lowest pressure occurred at Calcutta and Dibrugarh, pressure was at least relatively high over Burmah to the east and over central or southwestern India to the west or southwest of these stations. With this type of pressure distribution the warm tropical air from the Bay of Bengal flowed northward and northeastward over Bengal and Assam to the foothills of the Himalaya Mountains. It seems logical that this warm, moist air, instead of passing over this high and steep barrier, was deflected to the east over a more or less rugged terrain, but still much less elevated than the Himalayas, and a day or two later passed over the Phu Lien section, causing the fall in pressure there, then passing out over the China Sea parallel to (but in opposite direction) from the cold polar air from the Siberian anticyclone. Almost invariably the cyclone definitely formed just about the time the crest of the pressure rise passed Irkutsk, Siberia.

During the first four months of 1925 there were 15 well-marked troughs in the Dibrugarh pressure-change graph that were followed by cyclonic development to the east of Phu Lien and southwest or south of Japan, and only one distinct trough, that of January 14, was not followed by such cyclonic development. The average departure from normal pressure at Dibrugarh at the lowest point in each trough was −0.14 inch, and the average elapsed time thereafter when a cyclonic circulation was definitely established east of Phu Lien (using only one observation per day), was two and one-half days. The cyclones formed, as a rule, from 1,500 to 2,000 miles east of Dibrugarh.

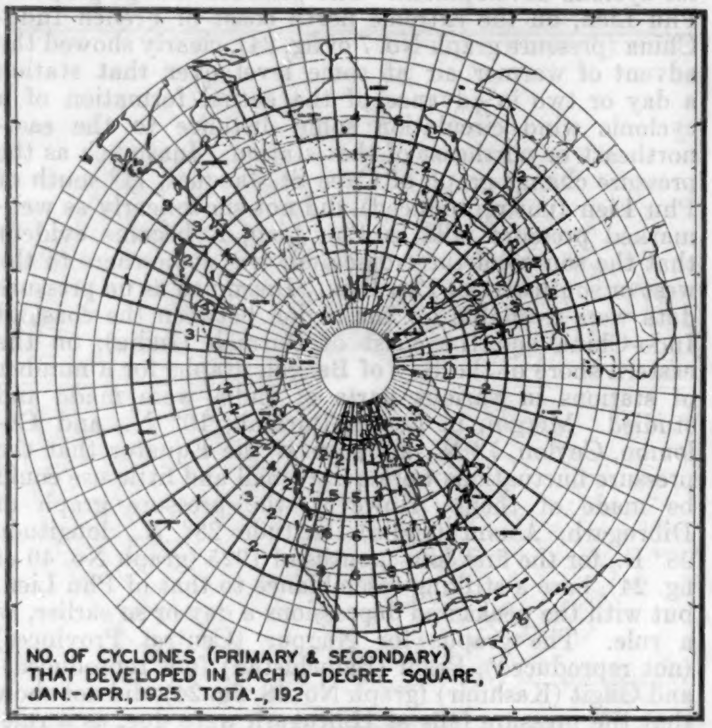


FIGURE 15.—Number of cyclones (primary and secondary) that developed in each 10-degree square, January-April, 1925

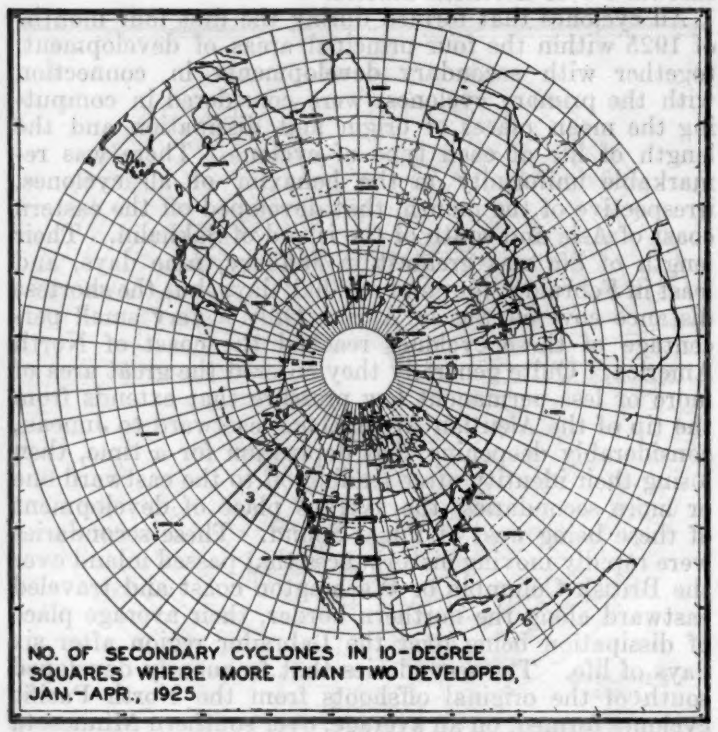


FIGURE 17.—Number of secondary cyclones in 10-degree squares where more than two developed, January-April, 1925

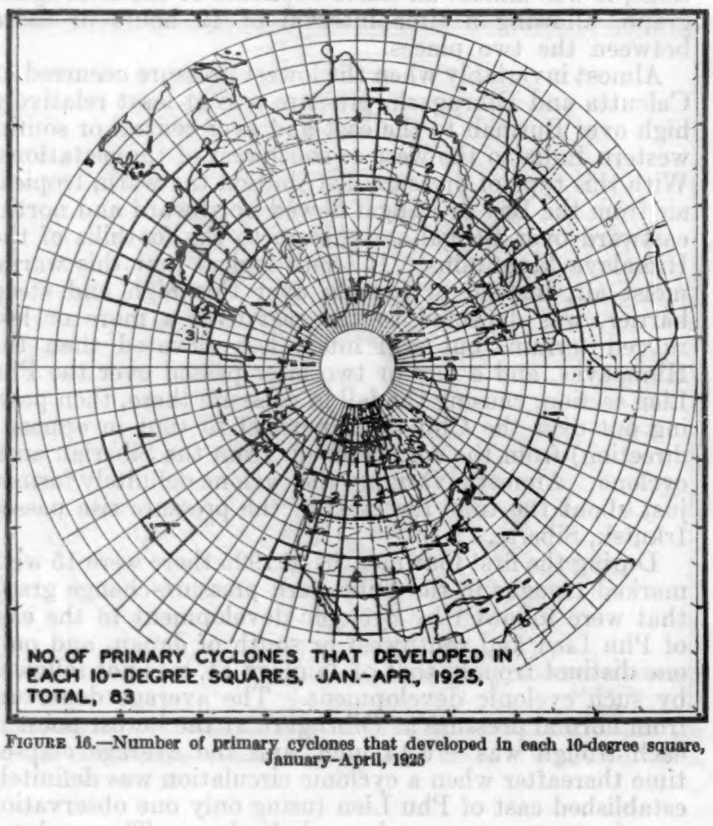


FIGURE 16.—Number of primary cyclones that developed in each 10-degree square, January-April, 1925

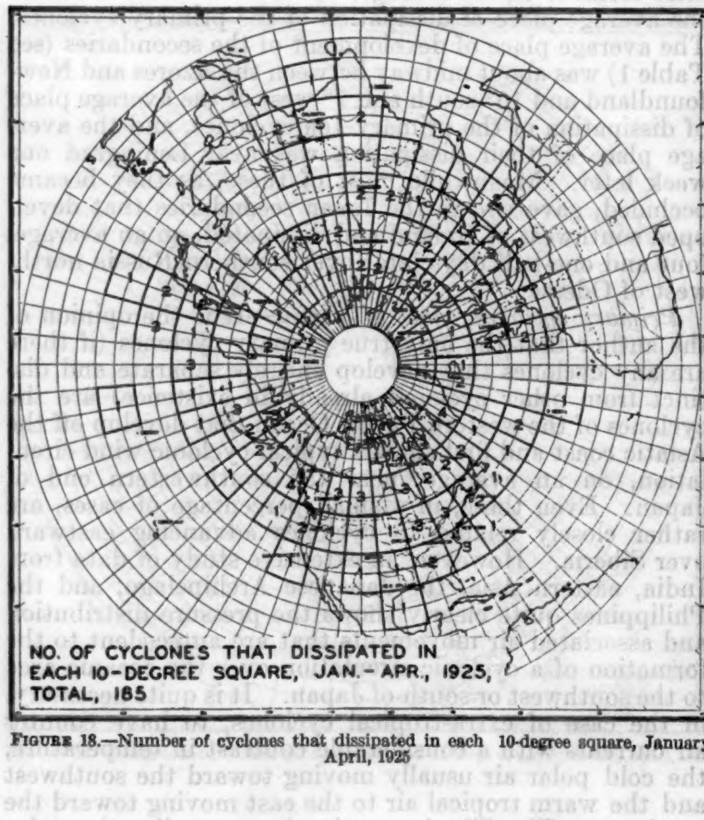


FIGURE 18.—Number of cyclones that dissipated in each 10-degree square, January-April, 1925

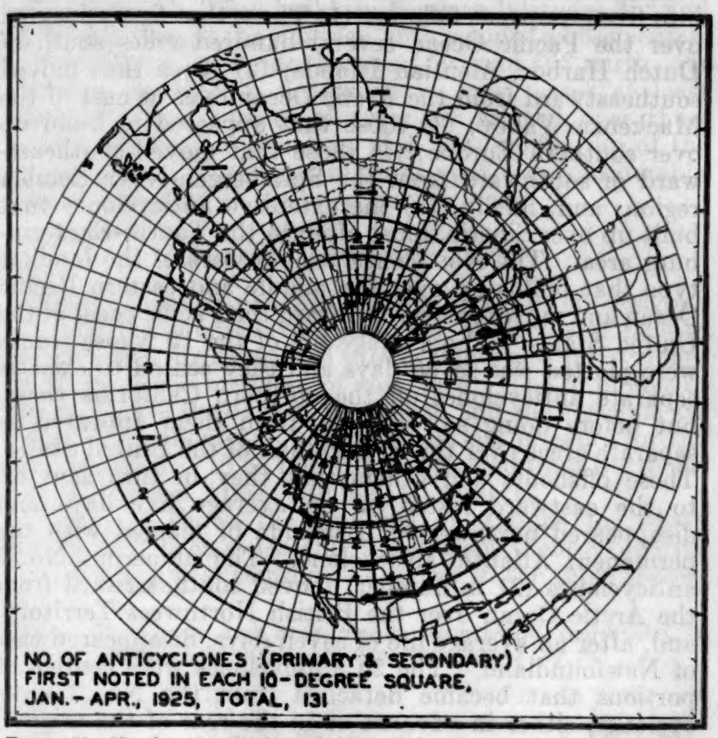


FIGURE 19.—Number of anticyclones (primary and secondary), first noted in each 10-degree square, January-April, 1925

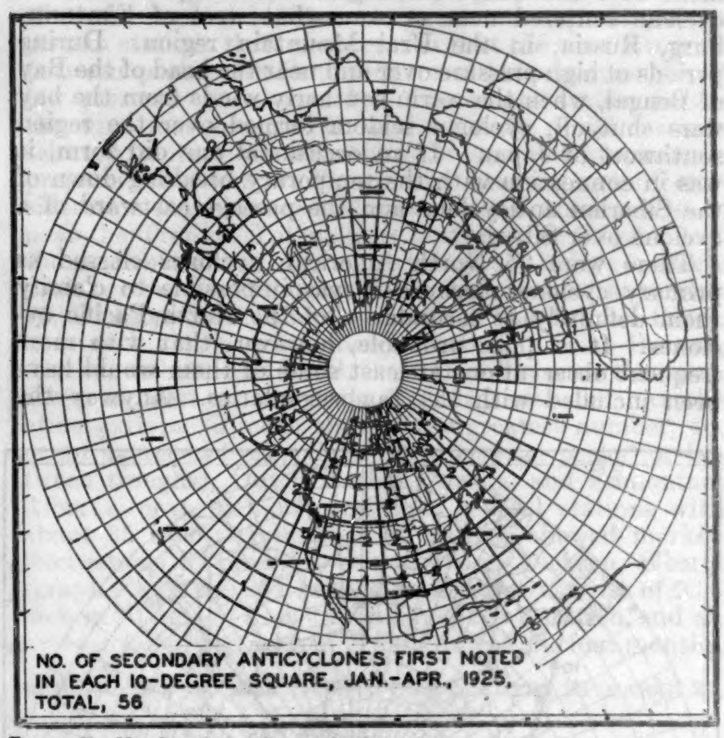


FIGURE 21.—Number of secondary anticyclones first noted in each 10-degree square, January-April, 1925

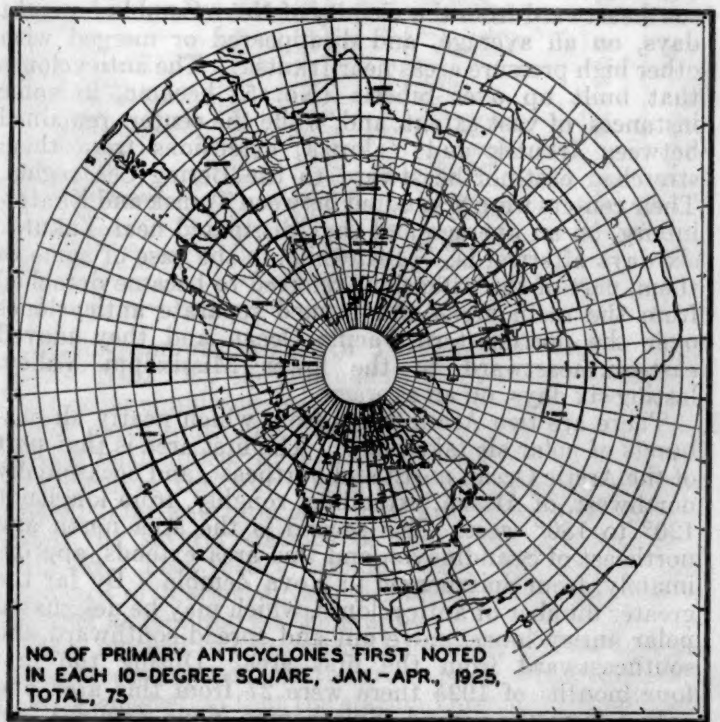


FIGURE 20.—Number of primary anticyclones first noted in each 10-degree square, January-April, 1925

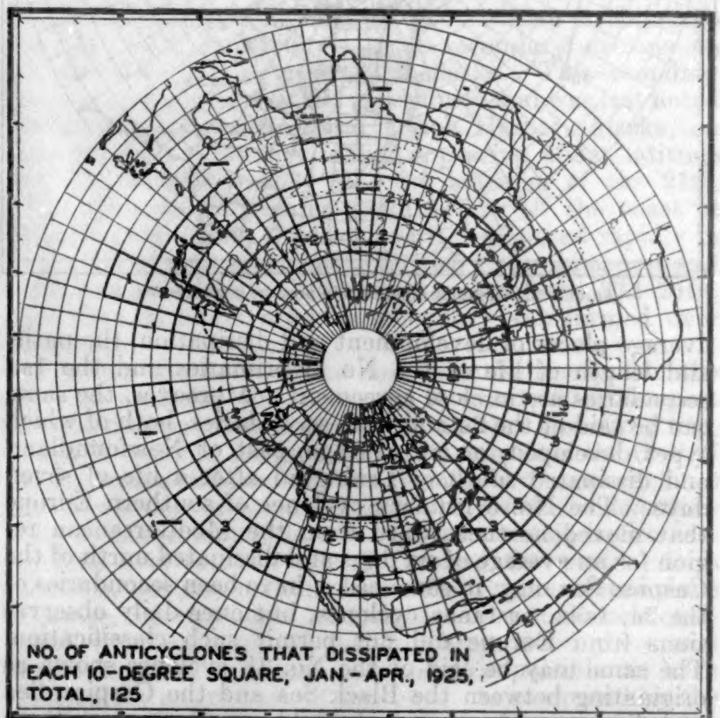


FIGURE 22.—Number of anticyclones that dissipated in each 10-degree square, January-April, 1925

Another interesting, but possibly unrelated, feature of the pressure distribution at the time of cyclonic development over the China Sea region was the presence of a cyclone centered near or somewhat west of Ekaterinburg, Russia, in the Ural Mountain region. During periods of high pressure over and near the head of the Bay of Bengal, when the warm southerly winds from the bay were shut off, cyclones seldom formed over the region southwest of Japan. If an occasional one did form, it was in connection with the temporary breaking down of the Siberian anticyclone and the passage eastward of a cyclone over Siberia.

There were 25 North American cyclones classed as primary cyclones because it was impossible to classify them definitely as secondaries of the North Pacific cyclones. It is quite probable, however, that with more frequent observations at least some of them would have been included with the 1aa secondaries. Anyway the

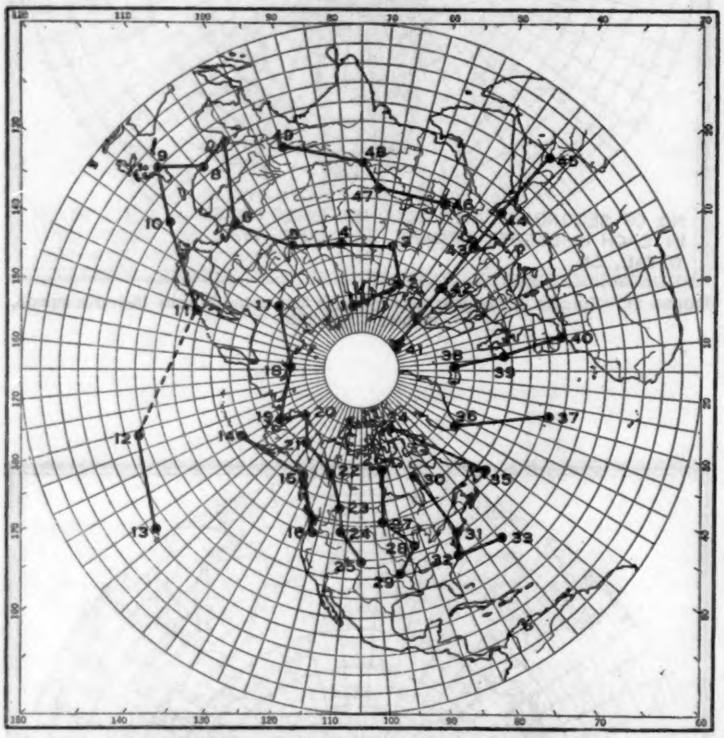


FIGURE 23.—Grouping of stations in pressure graph (see fig. 24)

average places of development and dissipation, the paths and length of life of the No. 2 primaries and the 1aa secondaries are in close agreement. Moreover, the same can be said of the 2a and 1aaa secondaries, both of which types developed, on an average, east of Newfoundland and dissipated south of Leningrad after a life of seven days. The No. 3 primary cyclones of southern Europe that moved northeastward from the Mediterranean region for an average of six days and dissipated north of the Caspian Sea may, in some cases, have been secondaries of the 2a, 1aaa, or 1aaaa cyclones, but once-daily observations from Europe did not permit such classification. The same may be said of the No. 3½ cyclones shown as originating between the Black Sea and the Caspian Sea and dissipating northeast of Tashkent, Turkestan, three and one-half days afterwards. The cyclones that originated over northwestern India moved east-northeastward slowly for about four days and dissipated just short of the Himalaya Mountains.

Anticyclones, place of origin.—Anticyclones that appeared on the daily weather maps during the first four months of 1925 were divided, according to place of origin, into five groups, as follows: (1) Those that first appeared over the Pacific Ocean several hundred miles south of Dutch Harbor, Aleutian Islands; (2) those that moved southeastward from the Arctic Ocean over or east of the Mackenzie Valley; (3) those that appeared to build up over southern Europe; (4) those that moved southeastward or southward from the Spitzbergen-Nova Zembla region; and, finally, (5) the extensive anticyclones that built up over Siberia, most often in the Tomsk-Ekaterinburg area. The No. 1 anticyclones were of the familiar type that builds up over the middle and eastern Pacific Ocean and moves eastward toward the Pacific coast of the United States. The average life of the 15 whose tracks were plotted was seven days and they ceased to exist as separate anticyclones off the northern California coast, but before doing so, offshoots from them appeared as separate areas over the western half of the United States. These offshoots and others that they in turn sent off to the eastward lasted on an average five days and disappeared northwest of Bermuda or merged with the permanent Atlantic anticyclone. The numerous No. 2 anticyclones (27 in number) moved southeastward from the Arctic Ocean over the British Northwest Territory, and, after an average life of seven days, disappeared east of Newfoundland. The 2*a* anticyclones were centers of portions that became detached from the No. 2 anticyclones, either in advance or in the rear of the original centers. The average movement was from eastern Ontario to the Azores and their average life, eight days. A number of anticyclonic areas apparently built up over southern Europe and moved, on an average from south of Vienna to the region south of the Caspian Sea in seven and one-half days. The No. 4 anticyclones moved southeastward from the vicinity of Nova Zembla for eight days, on an average, and disappeared or merged with other high pressure areas near Irkutsk. The anticyclones that built up over Siberia (No. 5) became, in some instances, of vast extent, and, while the centers remained between Irkutsk and Yakutsk, extensions from them stretched east-northeastward to the Bering Sea region. Their centers were first noted between Tomsk and Ekaterinburg, on an average and they dissipated near Yakutsk six days afterwards. Meanwhile, in the case of some of them, part of the extensions referred to became detached from the main areas and formed separate anticyclones over the northeastern Pacific Ocean and they moved east-southeastward to the lower Mississippi Valley, lasting six days, on an average.

There are two Arctic areas from which nearly all outbursts of polar air take place. The first area is that part of the Arctic Ocean north and northeast, and occasionally northwest, of Alaska, extending, roughly, from longitude 120° to 180° west. The second is the area north and northeast of Scandinavia, and this area extends, approximately, from Spitzbergen to Nova Zembla. By far the greater number of anticyclones, which may be designated polar anticyclones, move out and spread southward and southeastward from the first area. During the first four months of 1925 there were 27 from this area and only 4 from the second (Spitzbergen-Nova Zembla). It is because of the numerous polar anticyclones, together with the large number of cyclones from the Pacific Ocean, that Canada and the northern and middle portions of the United States east of the Rocky Mountains experience

more frequent material fluctuations of temperature than any other area in the northern hemisphere.

The other anticyclones (Nos. 1, 3, and 5) are of the mid-latitude type. They build up between latitudes 30° and 50° north, except the Siberian anticyclones whose centers first appeared, as a rule, between 50° and 60° north. It was not possible to determine in most cases at least whether or not masses of polar air arrived over these several areas simultaneously with the building up of the anticyclones. Their rate of movement was considerably slower than that of the polar anticyclones.

PRESSURE CHANGE GRAPHS

Briefly, these graphs (figs. 24, 24A, and 24B) are designed to show the progressive movement of rises and falls in pressure that are associated with cyclones and anticyclones which cross the meridian of any place. The ordinates of the graph are the days of the month and the abscissæ are the changes above and below the normal pressure for the time and place. The normals were scaled from Bartholomew's Physical Atlas, Volume III, plate 12.

Figure 23 shows the grouping of stations for which graphs have been given and the stations themselves with their geographical coordinates appear in the table below:

TABLE 2.—*Names and approximate geographical coordinates of stations used in pressure departure graphs (fig. 24)*

No.		Latitude	Longitude	No.		Latitude	Longitude
1	Dickson	73 N.	82 E.	26	Chesterfield Inlet	63 N.	91 W.
2	Oust Tsylma	66	53 E.	27	Winnipeg	50	97 W.
3	Ekaterinburg	56	61 E.	28	Chicago	42	88 W.
4	Tomsk	57	85 E.	29	Fort Smith	35	94 W.
5	Irkutsk	53	105 E.	30	Port Harrison	58	78 W.
6	Peking	40	116 E.	31	New York	41	74 W.
7	Phu Lien	21	107 E.	32	Hatteras	35	76 W.
8	Hong Kong	22	114 E.	33	Bermuda	32	65 W.
9	Manila	15	121 E.	34	Ponds Inlet	73	78 W.
10	Naha	26	128 E.	35	Saint Johns, New-		
11	Nemuro	43	145 E.		foundland	48	53 W.
12	Midway	28	177 E.	36	Ivigtut	61	48 W.
13	Honolulu	21	158 W.	37	Horta	39	29 W.
14	Dutch Harbor	54	164 W.	38	Seydisfjord	65	15 W.
15	Juneau	58	134 W.	39	Valencia	52	10 W.
16	Portland, Oreg	46	123 W.	40	Gibraltar	36	5 W.
17	Iakutsk	62	130 E.	41	Spitzbergen	78	14 E.
18	S. S. Maud	71	162 E.	42	Leningrad	60	30 E.
19	Nome	64	165 W.	43	Odessa	46	31 E.
20	Point Barrow	71	156 W.	44	Limasol	35	33 E.
21	Eagle	65	141 W.	45	Khartoum	16	33 E.
22	Simpson	62	122 W.	46	Baku	40	50 E.
23	Edmonton	54	113 W.	47	Tashkent	42	70 E.
24	Helena	47	112 W.	48	Gilgit	36	75 E.
25	Denver	40	105 W.	49	Dibrugarh	28	95 E.

If, for example, group No. 1 be considered with origin at 73° N.82° E., the movement of pressure changes, if they occur simultaneously at any two stations will appear in the north/south line, and in the graph in question they should next appear at Tomsk, this station being almost due south of Dickson. As a rule, however, the changes appear later and later and with a drift toward the east when the several stations of the group are favorably situated. The reader should trace for himself the sequence of marked pressure changes from one point to another as pictured on the graphs.

This method of comparison fails when the stations are too sparsely located. In the group being considered there is some suggestion that the station Oust Tsylma feels the pressure changes before Dickson does, and there is also unmistakable evidence that both stations do not experience changes of the same intensity as might be inferred from the fact that the same depression may not pass centrally over both stations.

TIME INTERVAL AND MAGNITUDE OF PRESSURE FLUCTUATIONS

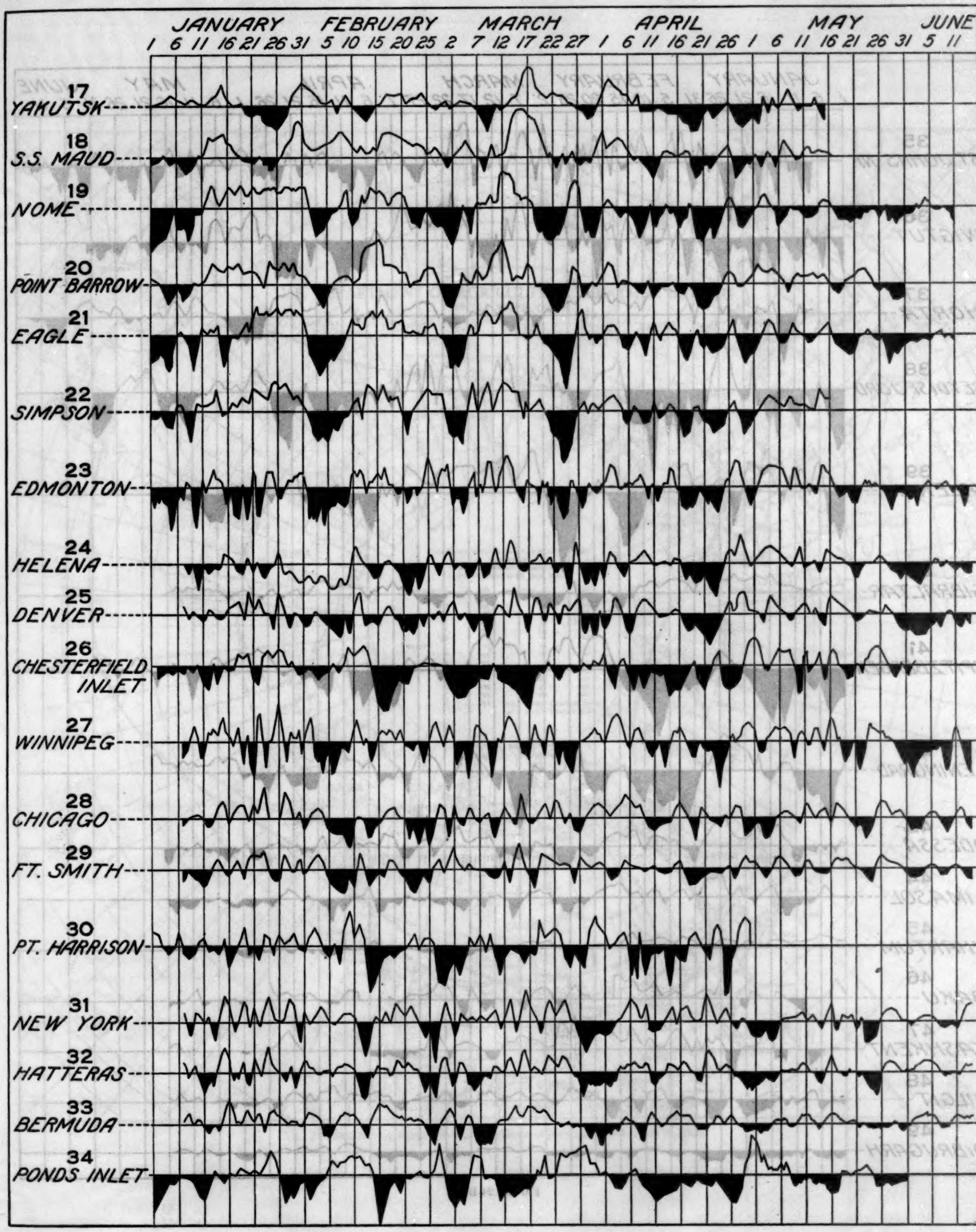
In studying the pressure-change graphs it was noted that the rises and falls were much more prolonged at certain stations than at others, so that the time intervals between peaks of high pressure and between troughs of low pressure varied greatly. The total number during the first four months of 1925 at each of 22 stations selected from a much larger number for which graphs were prepared is shown in Figure 15. Leaving out of consideration Honolulu and Midway Island which are in or near the Tropics, Yakutsk, in northeastern Siberia, had the smallest number, 10, or an average of 6.3 days between peaks or between troughs, Leningrad, Russia, next with 20, Dickson, Siberia, at the mouth of the Yenesei River, next with 22, then Spitzbergen with 23, Point Barrow, Alaska, with 26, and the S. S. *Maud*, off the northeastern Siberian coast at longitude 162° E., with 28. At the other extreme, Juneau showed the greatest number, 40, or an average of only three days between peaks (or between troughs), Dutch Harbor, Alaska, and Edmonton, Alberta, next with 39, and then several stations with about 35 each. A number of stations showed marked fluctuations in pressure, one of these, Dickson, Siberia (graph No. 7, fig. 24), having had an average rise of 0.56 inch in 20 rises of from two to six days duration, and an average fall of 0.51 inch in 21 falls during the four months.

AROUND-THE-WORLD CYCLONE OF FEBRUARY 23–MARCH 23, 1925

On the morning map of February 23, 1925, there appeared near Havre, Mont., a secondary disturbance, inclosed by a single isobar and apparently of little consequence, that was destined to become famous. Primary cyclone No. 4, Figure 4, developed southwest of Vladivostok, Siberia, on February 9 and dissipated near the western extremity of the Aleutian Archipelago on the 14th, immediately after secondary cyclone 4a appeared far to the south of Kamchatka. This secondary moved east-northeastward very slowly and was last noted some distance southwest of Dutch Harbor, Alaska, on the 20th, its secondary, 4aba, appearing about latitude 44° N., longitude 148° W., the morning of the 21st. This disturbance became quite severe off the coast of Washington during the 22d, but it diminished rapidly in intensity after it reached the British Columbia coast and disappeared entirely during the night of the 23d–24th, less than 24 hours after its secondary 4ab formed over Montana.

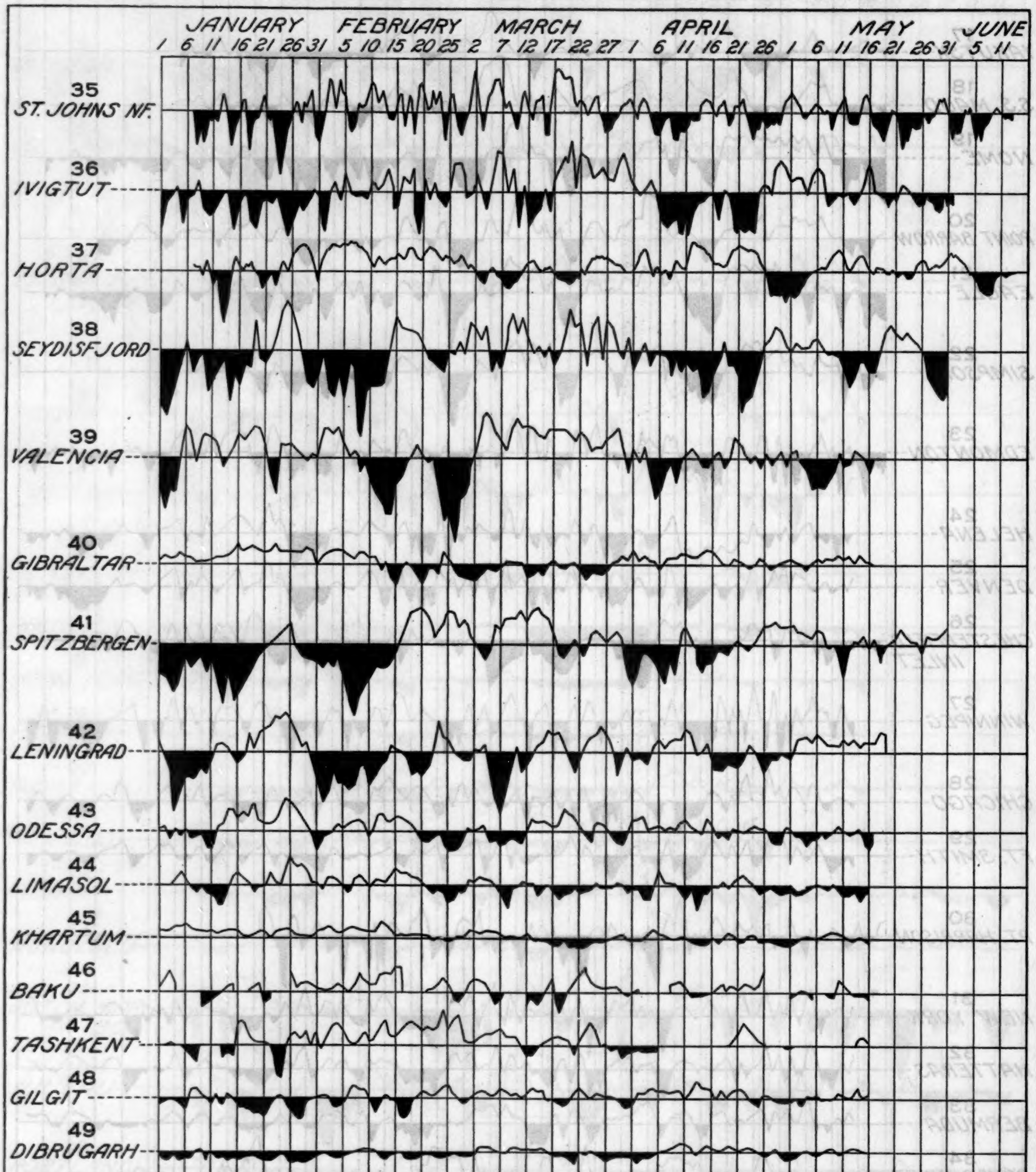
During the four weeks following February 23, the cyclone encircled the globe and it was 2,000 miles past its starting point, well started on another encircling trip, when it suffered an ignominious death over the Gulf of St. Lawrence on March 23 in a region where most cyclones are increasing in intensity and where few slacken their rate of movement. So far as is known this is the first cyclone ever tracked entirely around the world. It is possible, but not certain, that other cyclones have done likewise, but no other investigator ever had such complete weather maps of the Northern Hemisphere and without which it would have been impossible to have plotted the entire path of this one. As computed by the Hydrographic Office of the Navy Department, the approximate length of the cyclone and its secondaries was 18,565 nautical miles, or 21,379 statute miles. The approximate distance traveled by the center each 24 hours is shown in the center of Figure 25.

FIGURE 24.—Departure from normal pressure (daily) for 49 stations January-April, 1925



JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
1 6 11 16 21 26 31 5 10 15 20 25 2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 11
17 YAKUTSK
18 S.S. MAUD
19 NOME
20 POINT BARROW
21 EAGLE
22 SIMPSON
23 EDMONTON
24 HELENA
25 DENVER
26 CHESTERFIELD INLET
27 WINNIPEG
28 CHICAGO
29 FT. SMITH
30 PT. HARRISON
31 NEW YORK
32 HATTERAS
33 BERMUDA
34 PONDS INLET

FIGURE 24-A


JANUARY
FEBRUARY
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1 6 11 16 21 26 31 5 10 15 20 25 2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 11
35 ST. JOHNS NF.
36 IVIGTUT
37 HORTA
38 SEYDISFJORD
39 VALENCIA
40 GIBRALTAR
41 SPITZBERGEN
42 LENINGRAD
43 ODESSA
44 LIMASOL
45 KHARTUM
46 BAKU
47 TASHKENT
48 GILGIT
49 DIBRUGARH

FIGURE 24-B

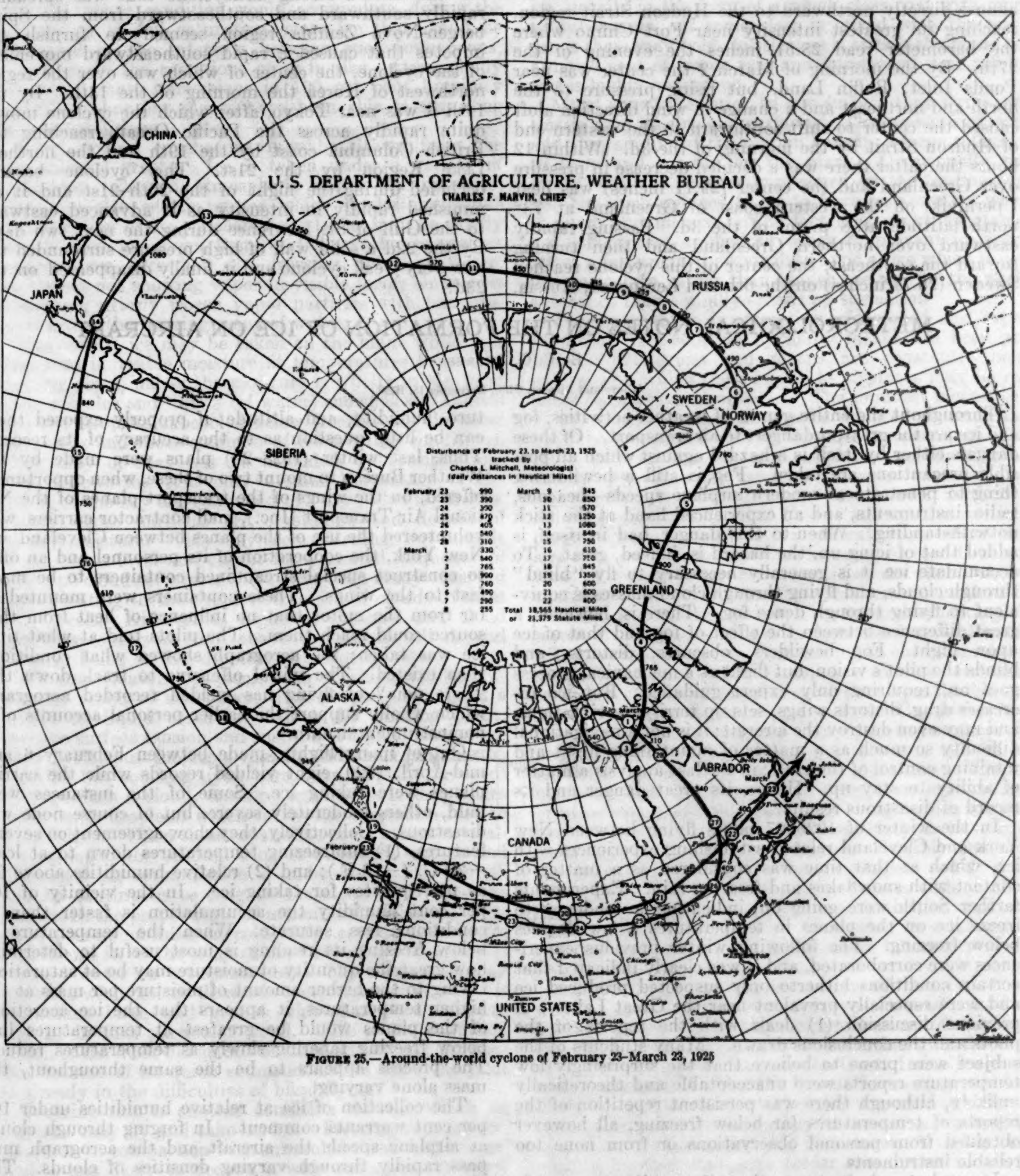

FIGURE 25.—Around-the-world cyclone of February 23–March 23, 1925

This cyclone increased rapidly in intensity after leaving Montana, the central pressure falling below 29 inches over northern New England and the lower St. Lawrence Valley on February 26. Its further progress toward the east was blocked by an area of high pressure that covered Greenland and extended southeastward to the Azores at that time. Consequently it moved almost directly northward to the Hudson Strait region, reaching its greatest intensity near Fort Chimo where the barometer read 28.51 inches the evening of the 27th. By the morning of March 2 the center was near Ponds Inlet, Baffin Land, but rising pressure to the north and northeast and a change in wind direction aloft caused the center to shift southward to the western end of Hudson Strait by the morning of the 3d. Within 12 hours thereafter there was a decided decrease in pressure over Greenland and the center (29.11 inches) was near Upernivik, on the western coast of Greenland at 73° north latitude at 8 p. m. of the 3d. Passing rapidly eastward over northern Greenland and then turning toward the southeast, the center of this cyclone reached Sweden (28.74 inches) on the 6th and Leningrad, Russia, (28.74 inches) on the 7th. The rate of movement lessened greatly and the cyclone decreased in intensity while moving almost directly eastward over northern Russia and Siberia during the next three days, after which its path turned more to the southeast and it was central some distance northwest of Irkutsk on the 12th. At this time a strong anticyclone that was spreading rapidly southward and southeastward from the Spitzbergen-Nova Zembla region seemed to furnish the impetus that caused a rapid southeastward movement of the cyclone, the center of which was over the region northwest of Korea the morning of the 13th. By the 14th it was near Tokyo, after which the cyclone moved quite rapidly across the Pacific Ocean, reaching the British Columbia coast by the 19th and the northern Lake Region by the 21st. This cyclone became occluded during the night of the 20th–21st and it diminished rapidly in intensity as it advanced eastward to the Gulf of St. Lawrence during the next two days. By the 22d a solid wall of high pressure surrounded the now very weak cyclone and it finally disappeared on the 23d.

METEOROLOGICAL NOTES ON THE FORMATION OF ICE ON AIRCRAFT

By C. G. ANDRUS

[Cleveland Airport, Ohio, December 15, 1929]

Throughout the entire gamut of weather activities, fog and ice are the greatest dangers to air transport. Of these dangers either by itself is a hazard against which all possible precautions are taken. Fog is still a bewildering thing to penetrate at modern airplane speeds—beacons, radio, instruments, and an experienced hand at the stick notwithstanding. When to this danger, bad in itself, is added that of icing up, the hazard is, indeed, great. To accumulate ice it is generally necessary to fly "blind" through clouds, and flying through cloud masses is equivalent to flying through dense fog. There is, however, a great difference between the effect of fog and that of ice upon flight. Fog bewilders, obscures, distorts, and blinds the pilot's vision, but flight as a mechanical process goes on, requiring only expert guidance. But ice increases drag, distorts wings, sets up terrifying vibrations, and may even destroy the aircraft; it is not a navigational difficulty so much as a matter of maintaining flight and retaining control of the craft; in the last analysis a matter of ability to stay up. Hence, its great danger and its record of disastrous results.

In the winter of 1926–27 pilots flying between New York and Cleveland related astonishing experiences with ice, which at that time was considered as a matter of contact with snowflakes and freezing rain. Experiments farther South were going on, indicating a tendency to freeze ice on the planes in temperatures a few degrees below freezing. The following winter previous experiences were corroborated, and it was clearly indicated that certain conditions hitherto only suspected produced ice and were especially prevalent near the Great Lakes. A previous discussion (1) deals with the reports of the pilots and the conclusions drawn. Many students of the subject were prone to believe that the surprisingly low temperature reports were unacceptable and theoretically unlikely, although there was persistent repetition of the reports of temperatures far below freezing, all however obtained from personal observations or from none too reliable instruments

It was but a short step to the self-recording aerograph. From it can be obtained verifiable records of temperature, humidity, and altitude; if properly exposed there can be little question as to the accuracy of its records. Thus, last winter (1928–29) plans were made by the Weather Bureau to mount two of these, when opportunity offered, on the wings of the transport planes of the National Air Transport (Inc.), mail contractor carriers, who volunteered the use of the planes between Cleveland and New York, the cooperation of its personnel and an offer to construct special streamlined containers to be made fast to the wings. These containers were mounted so far from the motor that no influence of heat from that source could reach them. The pilots told at what time ice was taken; the aerograph showed what conditions then existed. The initial offensive to track down this "bete noir" of flying has yielded recorded aerograms which wholly support the earlier personal accounts of a noninstrumental nature.

Out of many flights, made between February 6 and mid-April, 1929, eight yielded records while the carrier planes were taking ice. Some of the instances were mild, others moderately severe, but of course none was disastrous. Collectively, they show agreement on several features, (1) subfreezing temperatures down to at least −23 C. (−10 F.); and (2) relative humidities above 90, as prerequisites for taking ice. In the vicinity of 100 per cent humidity the accumulation is faster than in conditions less saturate. When the temperature is below freezing its reading is most useful to determine how great the quantity of moisture may be at saturation. Owing to the higher amount of moisture per mass at the higher temperatures, it appears that the ice accretions of the planes would be greatest at temperatures just below freezing tapering slowly as temperatures reduce. The process appears to be the same throughout, the mass alone varying.

The collection of ice at relative humidities under 100 per cent warrants comment. In forging through clouds at airplane speeds the aircraft and the aerograph may pass rapidly through varying densities of clouds. The air is usually turbulent in clouds, and the intensity of the opaque curtain of gray-white is usually noted by

fliers as varying in rapid fashion. It appears that within few clouds are there homogeneous masses of saturated vapor, but rather a mixture of saturated vapor and slightly less than saturated air, depending on the vertical activity of turbulence. An average relative humidity in the high nineties results in many cases. Within air masses of variable humidities, an airplane traveling through such a condition would accumulate, during the immersions in full saturation, more ice than could be dissipated in the intervals between such immersions; consequently the accretions grow in size. Occasionally are found short immersions in 100 per cent humidity conditions, but few planes have been able to stay long in such conditions.

Some general conclusions may be drawn from the instrumental graphs. Ice is taken under a variety of conditions. Certain atmospheric states are requisite; there are also certain states which render impossible the collection of ice. Because the latter may be briefly stated, they are given first, as follows: Air masses at temperatures exceeding the freezing point of water; air masses not showing vapor in visible form; air masses containing utterly frozen vapor particles with temperatures below the freezing point of water.

Conversely, ice may be taken on the plane while it is immersed in visible moisture at temperatures below the freezing point, unless the moisture is wholly in the form of ice spicules and "dry" (of water) snowflakes. Clouds of water droplets subcooled below freezing are the most dangerous and most common of ice-creating conditions. They may or may not be attended by precipitation. It is noteworthy that only a small percentage of the clouds of the sky are composed of "dry" clouds; that is, clouds whose particles are crystalline and devoid of watery moisture. This may seem startling, but outside of the cirrus level and except for a limited frequency of pall-type clouds of winter there have been many observed facts pointing to the droplet structure of clouds even at high levels. Iridescence, fogbows, coronae, and cloud rainbows (observed from above the clouds) all depend for their being on fine droplets of unfrozen water.

For some reason, the elucidation of which will be outside the realm of this paper, these droplets remain in a colloid or liquid state far below the freezing point; perhaps surface tension and suspended crystallization are responsible, but the facts remain and their explanation need be but touched upon here. An airplane proceeds through such a cloud, cracking against its leading edges many such droplets, which forthwith crystallize fast to these edges. Upon these crystalline coats others crystallize, as upon the original wing or structure surface and thereupon an accumulation is under way. The growth will be continuous as long as the cloud and plane are present in the proper state of action. The airplane or its parts possess no inherent cold which condenses moisture and freezes it, on the order of the "sweating" of a glass of ice-cold water on a summer day. The airplane simply provides what nature demands everywhere, that base for crystalline birth and growth which has been hitherto lacking in that particular cloud. This is the condition which is the most dangerous of those which may produce ice, because of its quick action at a time when the pilot is already in the difficulties of blind flying.

Freezing rain is another condition through which an airplane may fly and take on ice. Freezing rain is rare, however, in comparison with subcooled cloud frequencies, and is less likely to occupy a wide extent of territory, geographically or vertically. Here and there it develops as precipitation below clouds which are generally warm. Raindrops are either directly condensed as such, or are the result of the melting of snowflakes. Falling farther down they reach a cold substratum of air near the ground, in which they freeze or are reduced to subfreezing temperatures. The former action makes sleet; the latter, freezing rain and glaze. An airplane passing through the stratum in which the subcooling is proceeding will take ice, usually in the form of a rough clear coat with many protuberances. If some sleet is mixed with the water drops these may hold this sleet as it strikes the plane and a mixed coat of frozen rain and imprisoned sleet results; this is highly hazardous.

Moist snowflakes stick to any surface they strike, and this is true of airplane surfaces. The pressure of wind and the rapidity of the motion permits a large collection to form and solidify on the plane. Occasionally rain mixed with the snow is imprisoned on the leading edge and the slush reduced to ice to form an accretion which is rough and massive. The fact that sticky substances are somethimes applied to wings to prevent ice introduces a feature in the snowflake type of ice which is conducive to help rather than hinder the ice, for the sticky substance then actually speeds up the action.

The ice problem is attracting widespread and expert attention. Its solution by many means has been proposed and devices and means are constantly being evolved, by which the icing up of airplanes may be rendered harmless or impossible. The soundest means, that of avoidance, can not always be adopted as conditions must be recognized well in advance to assure avoiding those suitable for ice, and airplanes occasionally are caught unawares by sudden changes unanticipated. Nevertheless, avoidance is the best known method of reducing disasters in this field. Among the methods proposed may be named a few general types, whose chief aim is to prevent the ice from forming, or to rid the surfaces of it once it has formed. They are chemical, mechanical, or thermal. Briefly, the chemical method for lowering the freezing point of water and rendering the water of the droplets slow to form hard crystallization will solve the problem. Included in the chemical method are radioactive action, osmosis, slow dilution, and other schemes. The mechanical means range from flexible coving of the wings to guards and sprays. Under this head may be placed such means as highly polished surfaces and proposals to produce a hard surface which will be too repulsive to crystals to permit collections. Thermal methods embrace means for heating, from exhaust heat or otherwise, those portions of the wings which are subject to the accumulations. All these methods have stout champions and attractive features. Possibly the most conservative statement a meteorologist could make would be to the effect that nature operates with an abundance of energy in meteorological activities, and any method must not be merely acceptable in a laboratory test but should be tried in the larger laboratory of the free air.

Avoidance of ice conditions entails study of the weather map, apprehension of dangerous conditions from ground observations, and comprehension of the relationship between topography and weather over the route of flight. In the region near the Great Lakes ice conditions sometimes surprise the tyro at forecasting, and he is likely to predict fair weather for a period which will have pronounced ice-formation features. A fair example of such a condition occurred November 28 to 30, 1929, when a marked change to colder was drawn across the lower Lake region in the rear of a pronounced LOW. The temperature in the "polar front" fell to nearly

zero and as the vapor "steaming" off Lake Erie was mixed by turbulence and adiabatic cooling, great cumulus and strato-cumulus clouds developed and extended to great heights. Occasional outbreaks of thunder were reported. The entire process resulted from great difference between the temperature of the Lake surface and the cold air blowing southeastward over it. The thunder, snow and the ice-formation conditions resulting are repeated each time cold air passes over the relatively warm lake surface, and maintains a temperature below freezing. What is normally the clearing side of the retreating LOWS thus becomes the danger zone for ice in the vicinity of the Great Lakes. Apparently the greater the horizontal temperature gradient to the north of the Lakes and the lower the dew point in that section the greater will be the scope of the condensation on the south side of the Lakes in northwest winds.

Besides the strip of hazardous territory immediately bordering the Lakes another strip is usually found on the western slopes of the Appalachian Highlands in Pennsylvania, and New York. Here the southeastward bound air is again chilled, this time through mechanical raising by the hills. The clouds in such cases form on the hills, obscuring all high ridges, and rendering it necessary to fly through these clouds in order to get over the ridges, and an intensely dangerous condition exists, far worse than may be found over the more level terrain near the Lakes where a small margin between ground and clouds is a safety zone in many instances.

In theory, it may be assumed that the dew point at the ground must be below freezing to permit ice to form on airplanes in the base of the lower clouds over that ground, especially in turbulent conditions. Practically, it is believed that this holds forth some index to dangerous ice conditions, and later it may be possible to advise caution only in areas where ground dew points are below freezing or tending rapidly to attain values below freezing. If there are clouds in the sky under turbulent conditions, their altitude may be calculated by assuming the dry adiabatic lapse rate of temperature corrected for expansion to be in effect and from this reckoning the altitude required to correspond to the difference between dry-bulb temperatures and dew-point temperatures. Both the temperature and altitude of the cloud bases are then available, and these may be referred to surrounding terrain to determine whether clearance may be had over near-by ridges. Another valuable assumption is that the temperature of the base of the clouds will furnish an index so the added altitude necessary to reach temperatures below freezing if this cloud base is above freezing. Such an index is useful in permitting short immersions in clouds to hurdle mountain ridges, if only a short climb is necessary. The lapse rate of temperature for the wet or condensation stage is used. Tabulations of these three sets of factors have just been prepared andtheir trial during the coming winter months is expected to indicate whether they furnish much genuine help to the pilots.

When planes are equipped with readable thermometers and hygrometers, and the meteorologist is armed with many more supporting facts for his few favored assumptions, the question of avoidance will be easier of solution whatever results are obtained by those who labor to develop preventive means. In addition to the two aerographs used last year between Cleveland and Hadley Field, N. J., two more are available this winter, and will be used between those points and between Chicago and Cleveland and Kansas City, and should furnish further light on an interesting and complicated phenomenon.

REFERENCE

(1) "The Problem of Combating Ice Accumulation," by C. G. Andrus, Aviation, Vol. XXIV, No. 16, of April 16, 1928.

NOTES, ABSTRACTS, AND REVIEWS

Henry Joseph Cox, 1863–1930.—In the death of Prof. Henry Joseph Cox at Chicago on January 7, 1930, the Weather Bureau, Department of Agriculture, loses a weather forecaster of wide experience and mature judgment and an executive of rare ability.

Professor Cox was born at Newton, Mass., April 5, 1863, son of Thomas and Hannah Perkins Cox; he attended the primary schools of his native city, was graduated from Harvard University with the A. B. degree in 1884, and received the honorary A. M. degree from Norwich University in 1887, and the degree Sc. D. from the same institution in 1914. He married Mary, daughter of C. C. Cavanagh and Martha Cavanagh in 1887, and is survived by his wife and two sons, Henry Perkins and Arthur Cavanagh; a third son, Paul Greenwood, was killed in action at Soissons, France.

He entered the Weather Bureau (then the Signal Service) on August 1, 1884, and after completing a five months' course in training at Fort Whipple, Va. (now Fort Myer), was assigned to the Chicago station as an assistant observer in January, 1885; in August of the same year he was transferred to the Boston, Mass., station where he served until November 16, 1886; on November 17 of that year he opened the Weather Bureau station at Northfield, Vt., and served as its first official in charge until April 26, 1888; he was then transferred to charge of the New Haven, Conn., station and continued in charge until his appointment as a local forecast official in October, 1894. He was then assigned to the Chicago station, the second time, but now as an assistant to the local forecaster in charge of that station. In 1898, on the creation of the north central forecast district, Cox was placed in charge and he continued in that position until his death; his forecasting activities cover, therefore, a period of 35 consecutive years, 31 of which were as a district forecaster, a record not surpassed by any other Weather Bureau forecaster.

As an official in charge of station, Cox's dominating idea was service to the public—a service that he placed on a very high plane and for which he never had occasion to apologize. His intense loyalty to that service was perhaps the outstanding feature of his administration of the Chicago station. Like many other leaders of men, he inspired his assistants, both by example and precept, to put forth their best efforts. He was an outspoken and an uncompromising enemy of all forms of quackery that by insidious methods sought to creep into the art of weather forecasting.

In his contacts with the general public Cox sought to ally himself with commercial organizations and especially with educational and scientific institutions. While at Northfield, Vt., he inaugurated a course in meteorology in Norwich University, located at that place.

While at Chicago his relations to the Geographic Society of that city were intimate and helpful; in collaboration with Armington, his first assistant, he prepared a monograph on the weather and climate of Chicago (Bull. 4 of the society). He was a past president of the society and the recipient on December 28, 1928, of the Geographic Society of Chicago's gold medal awarded

"For eminent achievement in meteorology and for priceless service in the upbuilding of this society."

As an investigator he will be remembered by his two major studies, the first upon frost and temperatures in the cranberry bogs of Wisconsin and the second on the thermal conditions in western North Carolina as affecting fruit growing in that region.

He was also joint author in the publication Weather Forecasting in the United States, 1916.—*A. J. H.*

Death of Prof. Felix M. Exner.—Under date of February 15, 1930, Dr. E. van Everdingen, president of the International Meteorological Committee, announced to members of that committee the sudden death of Prof. Felix M. Exner, the director of the Austrian Meteorological Service at Vienna. Professor Exner will be kindly remembered by the older members of the Weather Bureau staff as a visitor to the bureau in 1904. An account of that visit may be found in Meteorologische Zeitschrift XXI: 465–68.—*A. J. H.*

Note on the British Isles rainfall predictions [1] (by Dinsmore Alter, University of Kansas, fellow The John Simon Guggenheim Memorial Foundation).—The agreement for the fifth year of these test predictions has been excellent. They called for an unusual drought for the first half year, and that which occurred actually exceeded the predictions. For the second half year they call for almost exactly the normal rainfall, and at the end of November this seems to be the correct result.

For the first half of 1930 they call for a considerable excess.

The correlation between prediction and observation is +0.66 for the five years, with a probable error of about ±0.13; we may begin to feel some confidence that it is not accidental.

The work is at present being repeated with a compilation made from manuscripts in the British Meteorological Office. There will be used 203 years of data instead of 91 of the previous paper; moreover, the record is a better one during the years which the two duplicate. The prediction will be attempted for quarters instead of halves of years.

January, 1930, cyclones and anticyclones.—The outstanding features of the cyclones of the month were their very pronounced instability and their tendency to take the form of a low-pressure trough from which weak secondary depressions would appear and persist for a short time. But a single one of the many cyclones that were plotted on the daily weather maps for the month had sufficient coherence to enable it to cross the continent.

High pressure in the Canadian interior was responsible for the large number of weak cyclones that passed into the Pacific Coast States and dissipated over the Southern Plateau. Anticyclones, on the other hand, moved eastward rather than southeastward as in a normal January. Near the close of the month a great anticyclone with central pressure of 31.10 inches in the Province of Alberta and pressures of 31 inches over southern Idaho rapidly dissipated in two or three days instead of dominating the weather for at least 10 days, as might usually have been expected.—*A. J. H.*

Climate, by C. E. P. Brooks, D. Sc., London, 1929.—In this small volume of 199 pages the author presents a running verbal account of the climates of the earth. The treatment is unique in that the use of graphs and diagrams is nearly avoided, there being but three graphs in the complete work. Appropriate tables of climatic data, one for each of the 23 subdivisions of the six major divisions of the surface of the globe, are presented.

The major subdivisions are as follows:

II. The North Temperate regions (five subdivisions).
III. Mediterranean climates (two subdivisions).
IV. North tropical climates (five subdivisions).
V. Equatorial climates (four subdivisions).
VI. Subtropical and temperate climates of the Southern Hemisphere (four subdivisions).
VII. The polar regions (three subdivisions).

The style of treatment requires great condensation; that the author has successfully reached the goal is evidenced by the 199 pages of type and tables each measuring 6¼ by 3$^{15}/_{16}$ inches.—*A. J. H.*

Sun Spots and the Distribution of Pressure Over Western Europe,[2] *by C. E. P. Brooks, D. Sc.*—Doctor Brooks made an investigation into the relations between the position of any month, quarter or year in the 11-year sun-spot cycle and the distribution of pressure over western Europe and the eastern North Atlantic. Two aspects of the question were considered:

(1) Whether there is any relation between the position of a month in the sun-spot cycle and the type of pressure distribution over the area as a whole.

(2) Whether there is any relation between the position of a quarter or year in the sun-spot cycle and the actual pressure at individual stations.

The results of the investigation as to the first aspect yielded little significant material, and as regards the second I quote the closing sentence of the author's conclusions: "It appears therefore, that at present the variations of sun-spots in the 11-year cycle can not be taken into account in predicting quarterly mean deviations of pressure in the eastern North Atlantic or western Europe."

Flying Over Rough Country in Bad Weather, by Paul A. Miller, Bolling Field.—Fogs, other than the radiation type are generally rare in inland sections during the summer months and are seldom considered to be a factor in flying weather conditions there at those times. However, in one instance known to the writer, a summer fog of the advection type very nearly cost a mail pilot his life.

It was during the latter part of June, 1929, when this occurred. For several days an overcast sky with fog beneath, had persisted from Fairfield, Iowa, southward to beyond Unionville, Mo., on the Chicago-Dallas Airway. This condition was probably due to the fact that an area of high pressure covered the northern Plains States and an area of low pressure covered the southern sections. There is a rise of ground of about 400 feet near and around Unionville and the cool northerly winds out of the high-pressure area were forced upward over this, with consequent formation of fog and low overcast. At other points where the terrain is level these conditions were not apparent.

The northbound mail ship, piloted by James Cleveland, took off from Kansas City for Chicago at about 7 a. m. The pilot was aware that this strip of overcast and fog was present near Unionville, but intended to fly over it, as he knew that Winfield and Moline were clear. He also rather expected that the hot June sun would soon burn this condition out.

However, upon nearing Unionville he decided to try to fly underneath the ceiling, as conditions did not appear as bad as the reports had shown and the ceiling seemed to have a fair clearance over the hills. As he flew along

[1] Presented at the December, 1929, meeting of the American Meteorological Society at Des Moines, Iowa.

[2] Brooks, C. E. P., Sun Spots and the Distribution of Pressure Over Western Europe. Professional Note No. 49 (ninth number in Vol. IV), London, 1928.

under the first part of the overcast he found that the fog was increasing and the visibility decreasing steadily. After about 10 minutes the fog became dense and merged with the ceiling until he could not see the ground from an elevation of 100 feet and had practically no horizontal visibility.

Having flown over this country regularly for a year, he was quite familiar with the terrain and decided to continue at a very low altitude for a few minutes, with the hope that conditions would improve. Instead of improving, the fog became denser, until he was flying blind barely over the treetops. The air became rough and set the compass to spinning and he finally became lost. He decided to land in any field that he could get down in. In a few minutes he had a glimpse of a field that looked suitable, but was past it before he could cut his engine and land. He banked to turn into the field and was flying, so low that the low wing took a large limb off a tree. Then he found that the field was so small that he "couldn't even get his tailskid in it," to use his own words.

He flew around aimlessly for about 15 minutes, after which the air became smoother, and he was able to set a compass course for Moline. He ran out of the fog and overcast within five minutes after finding the course and the rest of his trip was uneventful.

When asked what his reaction was while in the fog, he stated: "I was too busy dodging trees and hilltops to be worried where I would end up, but I believe that I will try to avoid all the blind flying that I can hereafter."

It is believed that the foregoing incident shows how highly important an accurate knowledge of weather conditions ahead is to the pilot, for had he known the exact conditions to be met he would never have attempted to fly underneath the extremely low ceiling present, but would have flown over the top of it, knowing that it was clear to the north.

As a passing thought of comment, pilots are always adverse to flying over the top of bad weather conditions, unless they know the extent of the overcast area. They are apprehensive that they may be drifted off their course by unknown air currents, and later will have to come down through a cloud layer that may be practically on the ground. In this case they would not be aware that they were near the ground until too late to avoid a crash, as the pressure altimeter has a very appreciable lag when ascending or descending.

Meteorological summary for Chile, December, 1929, by J. Bustos Navarrete, Observatorio del Salto, Santiago, Chile.—In December, 1929, there was a slight increase in the intensity of the atmospheric circulation over the Pacific Ocean with an accompanying increase in rainfall in the southern region of the country.

The principal anticyclones were charted as follows: 1st–5th, 9th–10th, and 26th–30th; the principal depressions: 7th–8th, 10th–12th, 18th–20th. The latter storm brought general rains from Aconcagua to Chiloe and much snow on the cordilleras.

In the central zone of Chile the periods of warm weather were marked by only slight intensity.—*Translated by W. W. R.*

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C. FITZHUGH TALMAN, in Charge of Library

RECENT ADDITIONS

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Commission de météorologie agricole.
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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING JANUARY, 1930

By HERBERT H. KIMBALL, Solar Radiation Investigations

For reference to descriptions of instruments and their exposures the reader is referred to this REVIEW, 57:26, January, 1929. Since that date there have been added to the stations for which data are published in Table 2, La Jolla, Calif., latitude 32° 50′ N., longitude 117° 15′ W., altitude 26 meters above sea level; Gainesville, Fla., latitude 29° 39′ N., longitude 82° 21′ W., altitude 71 meters; and Pittsburgh, Pa., latitude 42° 26′ N., longitude 80° 0′ W., altitude 341 meters. The records from La Jolla are furnished by Mr. Burt Richardson, Scripps Institution of Oceanography, University of California, and are made by a Weather Bureau thermoelectric pyrheliometer in connection with an Engelhard recording microammeter. The records from Gainesville are furnished by Mr. Mark D. Butler, College of Engineering, University of Florida, and are made by a Moll thermoelectric pyrheliometer recording on a Richard microammeter. Both of these recording pyrheliometers were standardized at the Weather Bureau observatory, American University, D. C., by comparison with Weather Bureau substandard pyrheliometers, which, in turn, are standardized by comparison with Smithsonian standard instruments. This is true of all the instruments used in obtaining records that are published in Tables 1 and 2. The Weather Bureau station in

Pittsburgh was equipped with a Weather Bureau thermoelectric pyrheliometer and an Engelhard recording microammeter near the end of December, 1929.

Table 1 shows that there were only a few days in January at Washington when the sky was sufficiently free from clouds to justify measurements of the intensity of direct solar radiation, and on these days the intensities on the whole were close to the average for January. At Madison measurements were obtained on an unusually large number of days, but the presence of smoke caused the intensities to average low. At Lincoln there were many clear days during the last decade of the month, with intensities only slightly below the average.

Measurements of the total solar radiation received on a horizontal surface summarized in Table 2, show a decided deficiency at Washington, New York, and La Jolla, close to the average at Madison, and an excess at the remaining stations for which average weekly values have been determined.

On account of a snow cover at Washington and Madison during most of the month skylight polarization measurements were not obtained.

TABLE 1.—*Solar radiation intensities during January, 1930*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
		Sun's zenith distance									
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Jan. 4	2.87			1.13	1.27			0.98	0.76		2.16
Jan. 6	3.63	0.84	0.98	1.16	1.27						4.37
Jan. 9	10.21				1.15						01.59
Jan. 25	1.78		0.75	1.07	1.28		1.20				2.36
Means		(0.84)	(0.86)	1.12	1.24		(1.20)	(0.98)	(0.76)		
Departures		+0.11	+0.02	+0.11	+0.01		−0.03	−0.05	−0.11		

Madison, Wis.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Jan. 2	2.74	0.80	0.91	1.04							3.99
Jan. 3	1.60	0.98	1.10	1.27				1.25			1.37
Jan. 7	0.91	0.79	0.97	1.11				1.09			0.96
Jan. 10	0.91	0.93	1.07	1.23				1.00			1.07
Jan. 16	1.07							1.18			0.91
Jan. 20	1.02							0.87			0.91
Jan. 21	0.51		0.73	1.03							0.58
Jan. 22	0.36			0.93				1.08			0.51
Jan. 23	0.43		0.61	0.90							0.86
Jan. 25	1.12			1.24	1.44						0.66
Jan. 28	0.96		0.74	1.14	1.42			1.29			1.52
Jan. 29	0.58		0.61	0.82	1.36						1.07
Means		0.88	0.84	1.07	1.41			1.11			
Departures		−0.07	−0.21	−0.14	+0.05			−0.09			

Lincoln, Nebr.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Jan. 3	2.16							1.15	1.02	0.89	3.15
Jan. 4	2.49	1.01	1.12	1.24	1.37			1.10	0.84		2.49
Jan. 21	0.46	0.95	1.07	1.22	1.43						0.66
Jan. 22	0.46		1.04	1.23	1.42			1.25	1.11	0.97	1.07
Jan. 23	0.74	0.56	0.78	0.97	1.33						1.60
Jan. 24	1.45							1.20	1.07	1.00	1.96
Jan. 25	1.24		1.08	1.17							1.52
Jan. 28	1.24			1.18	1.40		1.39	1.19	1.07	0.94	1.52
Jan. 29	1.32	0.86	0.91	1.08	1.29						2.62
Means		0.84	1.00	1.16	1.37		(1.39)	1.18	1.02	0.95	
Departures		−0.09	−0.05	−0.02	−0.01		−0.03	+0.01	−0.03	+0.03	

[1] Extrapolated.

TABLE 2.—*Total solar radiation (direct-diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning	Washington	Madison	Lincoln	Chicago	New York	Pittsburgh	Gainesville	Twin Falls	Fresno	La Jolla
	Average daily totals									
1930	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	158	122	185	112	128	106	302	205	185	195
Jan. 8	90	95	145	47	49	48	250	243	168	156
Jan. 15	123	187	234	162	75	103	172	295	166	190
Jan. 22	165	227	272	229	144	126	296	281	216	192
	Departures from weekly normals									
Jan. 1	+6	−14	+1	+30	+18			+29	+39	−37
Jan. 8	−63	−50	−44	−35	−56			+60	+15	−63
Jan. 15	−34	+25	+33	+65	−40			+104	−18	−25
Jan. 22	−15	+38	+50	+117	+1			+101	−10	−39
Accumulated departure on Jan. 28	−742	−7	+280	+708	−539			+2,058	+104	−1,148

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. C. S. Freeman, Superintendent U. S. Naval Observatory. Data furnished by Naval Observatory in cooperation with Harvard, Yerkes, Perkins, and Mount Wilson observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time		Heliographic: Diff. long.	Longitude	Latitude	Area: Spot	Group	Total area for each day
1930	h	m	°	°	°			
Jan. 1 (Naval Observatory).	11	42	−85.0	47.3	−5.0		247	
			−73.0	59.3	+10.0	31		
			+12.5	144.8	+12.0		139	
			+62.5	194.8	+17.5		386	803
Jan. 2 (Naval Observatory).	13	21	−76.0	42.3	−6.0		432	
			−73.0	45.3	+5.0	139		
			−59.0	59.3	+9.5	31		
			+27.0	145.3	+11.5		77	
			+78.5	196.8	+17.0	247		926
Jan. 3 (Naval Observatory).	11	8	−64.0	42.3	−6.0		309	
			−61.0	45.3	+5.0	123		
			−47.0	59.3	+9.5		31	
			−19.0	87.3	+5.0	3		
			+37.5	143.8	+12.0		62	528
Jan. 4 (Naval Observatory).	11	13	−49.5	43.6	−6.0		216	
			−46.5	46.6	+5.5	123		
			−33.0	60.1	+10.0	31		
			−15.5	77.6	−5.5	3		373
Jan. 5 (Naval Observatory).	11	16	−75.0	4.9	−8.5	77		
			−37.5	42.4	−5.0		340	
			−33.5	46.4	+5.5	123		
			−20.0	59.9	+10.0	31		571
Jan. 6 (Naval Observatory).	11	16	−76.5	350.2	+7.5	494		
			−76.0	350.7	−3.5	123		
			−61.5	5.2	−8.5	62		
			−24.5	42.2	−5.0		278	
			−19.5	47.2	+6.0	123		
			−6.5	60.2	+10.5	31		1,111
Jan. 7 (Naval Observatory).	14	4	−62.5	349.5	−3.0		154	
			−60.0	352.0	+7.0	478		
			−46.5	5.5	−8.5	31		
			−8.5	43.5	−5.0		231	
			−5.5	46.5	+5.5	123		
			+9.0	61.0	+10.0	31		1,048
Jan. 8 (Naval Observatory).	11	40	−53.5	346.7	−2.0		324	
			−48.5	351.7	+7.0	463		
			−36.0	4.2	−8.5		77	
			+3.5	43.7	−5.0		231	
			+7.0	47.2	+5.5	123		
			+21.5	61.7	+10.0	25		1,243
Jan. 9 (Naval Observatory).	11	12	−40.0	347.2	−2.0		401	
			−35.5	351.7	+7.0	432		
			−20.0	7.2	−8.0	31		
			+17.5	44.7	−5.0		154	
			+20.0	47.2	+5.0	108		
			+34.5	61.7	+10.5	25		1,151
Jan. 10 (Yerkes)	11	51	−66.0	307.8	+4.5	56		
			−29.0	344.8	−2.0		516	
			−22.5	351.3	−4.5	244		
			−21.5	352.3	+6.5	731		
			+33.5	47.3	+4.5	216		
			+36.5	50.3	−4.0		57	1,820

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time		Heliographic			Area		Total area for each day
			Diff. long.	Longitude	Latitude	Spot	Group	
1930	h	m	°	°	°			
Jan. 14 (Perkins)	16	25	−48.2	270.0	+15.3		465	
			+30.1	348.3	−2.5	211		
			+32.4	350.6	−4.9	146		
			+33.5	351.7	+6.6	1,234		2,056
Jan. 15 (Perkins)	13	19	−58.0	248.8	+13.7	93		
			−46.5	260.3	−14.6		183	
			−34.4	272.4	+14.8		1,048	
			−9.1	297.7	−12.9		93	
			+41.5	348.3	−3.0	546		
			+44.0	350.8	−5.3	217		
			+45.6	352.4	+6.4	1,203		3,383
Jan. 16 (Naval Observatory).	11	20	−80.5	214.5	+11.5	123		
			−56.0	239.0	−10.0	6		
			−46.0	249.0	+14.5		62	
			−31.5	263.5	−13.5		77	
			−22.5	272.5	+15.0		772	
			+0.5	295.5	−12.5		22	
			+25.0	320.0	−17.0		15	
			+41.5	336.5	+18.0		62	
			+44.0	339.0	+11.0		77	
			+55.0	350.0	−3.0		417	
			+58.0	353.0	+6.5	386		2,019
Jan. 17 (Naval Observatory).	11	31	−77.0	204.7	+14.5		154	
			−68.5	213.2	+10.5	93		
			−42.0	239.7	−10.5	6		
			−32.0	249.7	+14.0	46		
			−19.5	262.2	−13.5		77	
			−8.5	273.2	+14.5		694	
			+14.0	295.7	−12.0		40	
			+40.5	322.2	−15.5		46	
			+68.5	350.2	−2.5		324	
			+71.0	352.7	+6.5	370		1,850
Jan. 18 (Mount Wilson)	12	35	−73.0	195.0	+16.0	63		
			−60.0	208.0	+14.0		19	
			−52.0	216.0	+10.0	58		
			−25.0	243.0	−11.0	2		
			−20.0	248.0	+13.0		23	
			−5.0	263.0	−15.0		21	
			+5.0	273.0	+13.0		458	
			+28.0	296.0	−13.0		2	
			+55.0	323.0	−18.0		18	
			+85.0	353.0	−4.0	249		
			+87.0	355.0	−5.0	52		
			+88.0	356.0	+6.0	73		1,038
Jan. 19 (Naval Observatory).	11	40	−51.0	204.3	+14.0		231	
			−6.5	248.8	+13.5	6		
			+6.5	261.8	−13.5		77	
			+19.5	274.8	+14.0		525	839
Jan. 20 (Naval Observatory).	11	29	−37.5	204.7	+14.0		201	
			+6.5	248.7	+13.5	6		
			+12.5	254.7	−15.5	15		
			+33.0	275.2	+14.0		525	
			+84.0	326.2	−14.0	62		809
Jan. 21 (Mount Wilson)	13	15	−80.0	148.1	+12.0		142	
			−35.0	193.1	+15.0		87	
			−23.0	205.1	+14.0		10	
			−14.0	214.1	+10.0	4		
			+20.0	248.1	+13.0	15		
			+27.0	255.1	−15.0		3	
			+45.0	273.1	+13.0		221	482
Jan. 22 (Mount Wilson)	12	30	−70.0	145.4	+12.0		408	
			−22.0	193.4	+15.0		42	
			−10.0	205.4	+14.0		15	
			−1.0	214.4	+11.0	1		
			+34.0	249.4	+14.0	4		
			+62.0	277.4	+13.0		63	533
Jan. 23 (Naval Observatory).	11	31	−54.0	148.7	+12.5		463	
			−3.5	199.2	+12.0		108	
			+74.0	276.7	+12.5		154	725
Jan. 24 (Naval Observatory).	11	30	−41.5	148.1	+12.5		370	
			+6.0	195.6	+15.0		77	
			+48.5	238.1	−15.0		12	459
Jan. 25 (Naval Observatory).	11	33	−70.0	106.4	+17.0	31		
			−28.5	147.9	+12.0		293	
			+19.0	195.4	+15.0		62	386
Jan. 26 (Naval Observatory).	11	34	−43.5	119.7	+17.0	12		
			−14.5	148.7	+12.0		247	
			+32.5	195.7	+14.0		77	336
Jan. 27 (Yerkes)	16	44	−29.0	118.3	+17.0	16		
			−26.0	121.3	+17.5	20		
			+1.5	148.8	+12.5		384	420
Jan. 28 (Naval Observatory).	14	3	−74.5	61.0	+7.0	123		
			−15.5	120.0	+16.5		46	
			+13.0	148.5	+12.0		185	354
Jan. 29 (Mount Wilson)	13	35	−62.0	60.7	+8.0	101		
			−26.0	96.7	+7.0		11	
			−4.0	118.7	+17.0		69	
			+26.0	148.7	+11.0		37	
			+45.0	167.7	+4.0	5		223
Jan. 30 (Mount Wilson)	13	45	−81.0	28.4	+21.0	189		
			−47.0	62.4	+7.0	72		
			−12.0	97.4	+7.0		9	
			+11.0	120.4	+17.0		147	
			+40.0	149.4	+11.0		99	
			+61.0	170.4	+5.0		28	544
Jan. 31 (Naval Observatory).	11	58	−61.5	35.7	+19.5		324	
			−34.5	62.7	+6.5	123		
			+21.5	118.7	+17.5		201	
			+53.0	150.2	+11.0		170	
			+73.0	170.2	+5.5		93	911
Mean daily area for January								962

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR JANUARY, 1930 [1]

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

January, 1930	Relative numbers	January, 1930	Relative numbers	January, 1930	Relative numbers
1	37	11	Ec 65	21	d 76
2	d 42	12	bbd 67	22	60
3	55	13	a 91	23	65
4	38	14	89	24	a 49
5	49	15		25	39
6	d 55	16		26	34
7	a 62	17	107	27	Eac 31
8	a 68	18	b 137	28	
9	62	19	97	29	62
10	57	20	63	30	
				31	d 62

Mean, 27 days=63.7.

[1] Dependent alone on observations at Zurich and its station at Arosa.
a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a large or average-sized center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

By Richmond T. Zoch

Free-air temperatures were below normal at all stations except Due West, where they were above normal. (Table 1.) At most levels the negative departures at Ellendale, Broken Arrow, and Groesbeck were the greatest on record. This is significant in that the surface temperatures at Broken Arrow and Groesbeck show that these stations had the coldest Januarys on record, both stations establishing new absolute minimum temperatures. However, the mean temperature at Ellendale was slightly above the mean temperature of that station for January, 1929. In marked contrast, Due West had the warmest January on record and established a new absolute maximum for that month.

Free-air relative humidities were above normal at all levels at Broken Arrow, Ellendale, and Royal Center but below normal at most levels at Groesbeck and Due West. Vapor pressures were below normal with very few exceptions.

The free-air conditions, i. e., temperature, relative humidity, vapor pressure, and resultant winds over

Ellendale were strikingly similar to those of January, 1929, yet while January, 1929, had the greatest precipitation on record this month was one of the dryest Januarys for that station. However, the cloudiness was somewhat greater than for January, 1929, and the reason for these clouds producing scant precipitation this year can be explained by differing pressure distribution, the increased coludiness itself preventing observations to indicate differing resultant winds.

The resultant winds were variable in the lower levels throughout the United States. In the higher levels they were westerly. (Table 3.)

In addition to the flights given in Table 4, a special sounding balloon series was made at 10 regular Weather Bureau stations.

As explained in the December, 1929, Summary, Table 2 is not closely comparable with Table 1.

TABLE 2.—*Free-air data determined at naval air stations during January, 1930*

Altitude (meters) m. s. l.	Temperature (° C.)			Relative humidity (%)		
	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.
Surface	10.3	14.0	2.7	86	63	80
500	10.6	11.7	3.9	75	62	76
1,000	10.1	10.0	3.5	63	57	69
2,000	8.1	5.8	1.3	45	47	63
3,000	4.4	1.7	−1.3	37	31	53
4,000			−7.6			45

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during January, 1930*

TEMPERATURE (° C.)

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters										
Surface	−4.5	−7.7	5.4	−0.3	−17.4	−6.3	2.0	−6.0	−7.8	−3.5
500	−4.8	−7.6	5.4	0	−17.5	−6.5	0.3	−7.2	−9.1	−3.7
1,000	−3.6	−6.3	5.0	+0.4	−16.9	−8.1	2.4	−4.9	−8.9	−3.6
1,500	−2.9	−5.3	3.7	+0.6	−16.6	−8.5	2.7	−3.7	−9.2	−3.4
2,000	−3.6	−4.6	1.9	+0.7	−17.1	−7.5	1.7	−3.0	−10.1	−3.3
2,500	−4.9	−3.7	−0.1	+0.7	−18.1	−6.3	0.4	−2.2	−11.0	−2.3
3,000	−7.5	−3.8	−1.9	+1.0	−19.9	−5.5	0.3	0.0	−13.0	−2.0
4,000	−12.8	−3.6	−6.1	+1.8						

RELATIVE HUMIDITY (%)

Surface	76	+6	72	+3	84	+3	78	+1	84	+5
500	71	+7	61	−1	84	+5	71	+1	80	+6
1,000	65	+10	56	−1	80	+14	57	−4	69	+6
1,500	58	+12	50	−3	76	+17	55	+2	66	+10
2,000	55	+14	42	−7	75	+17	46	−2	65	+14
2,500	50	+10	41	−4	71	+13	35	−10	68	+16
3,000	49	+9	32	−10	65	+7	16	−25	66	+13
4,000	50	+8	26	−14						

VAPOR PRESSURE (*mb.*)

Surface	3.69	−1.99	7.06	+0.28	1.41	−0.99	6.79	−2.07	3.13	−0.68
500	3.44	−1.62	6.06	−0.04	1.39	−0.96	5.52	−2.28	2.69	−0.62
1,000	3.28	−0.92	5.36	0.00	1.28	−0.87	4.87	−1.63	2.20	−0.59
1,500	2.84	−0.53	4.11	−0.26	1.17	−0.80	4.29	−0.94	2.03	−0.30
2,000	2.47	−0.27	2.92	−0.60	1.06	−0.64	2.89	−1.29	1.80	−0.12
2,500	2.05	−0.25	2.43	−0.29	0.91	−0.48	1.62	−1.75	1.68	+0.03
3,000	1.74	−0.21	1.61	−0.50	0.69	−0.39	0.36	−2.30	1.45	+0.01
4,000	1.32	−0.09	1.25	−0.13						

TABLE 3.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during January, 1930*

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,868 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°	
Surface	N 11 W	0.5	S 20 W	2.7	W	3.7	N 44 E	1.0	N 51 W	2.8
500	S 40 W	0.5	S 41 W	5.8			N 14 W	1.4	N 49 W	3.8
1,000	S 86 W	3.3	S 70 W	7.9			S 80 W	2.8	N 40 W	6.0
1,500	N 74 W	5.2	S 85 W	10.9			S 76 W	6.0	N 46 W	7.2
2,000	N 61 W	7.7	N 89 W	14.1	S 87 W	5.8	S 80 W	7.9	N 53 W	8.7
2,500	N 60 W	9.9	N 88 W	14.3	N 79 W	8.3	S 77 W	11.2	N 63 W	11.6
3,000	N 61 W	11.8	N 83 W	17.8	N 72 W	9.9	S 59 W	11.5	N 62 W	13.5
4,000			N 83 W	23.4	S 82 W	10.4	S 74 W	17.2	N 71 W	14.4
5,000										

Altitude (meters) m. s. l.	Groesbeck Tex. (141 meters)		Havre, Mont. (762 metes)		Jacksonville, Fla. (65 meters)		Key West, Fla. (11 meters)		Los Angeles, Calif. (40 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°	
Surface	N 9 E	0.3	S 83 W	2.0	N 12 E	1.6	N 45 E	2.1	N 73 W	2.7
500	N 13 E	1.5			N 79 E	2.3	N 86 E	5.9	S 84 E	0.7
1,000	N 64 W	1.4	N 82 W	5.1	S 33 E	2.8	S 72 E	6.1	S 52 E	1.1
1,500	N 67 W	4.3	N 59 W	6.7	S 13 W	1.0	S 54 E	4.6	N 53 E	1.3
2,000	N 62 W	4.8	N 60 W	8.3	S 60 W	2.4	S 15 E	3.0	N 69 W	1.7
2,500	N 67 W	6.3	N 67 W	10.2	S 80 W	5.4	S 6 W	3.3	N 68 W	4.4
3,000	N 76 W	8.4	N 68 W	10.8	S 87 W	7.4	S 27 W	3.1	N 60 W	7.0
4,000					N 79 W	8.3	S 55 W	8.5	N 53 W	7.5
5,000					N 75 W	8.6				

Altitude (meters) m. s. l.	Medford, Oreg. (446 meters)		Memphis, Tenn. (145 meters)		New Orleans, La. (25 meters)		Omaha, Nebr. (313 meters)		Royal Center, Ind. (225 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°	
Surface	S 8 W	0.6	N 4 W	1.3	N 52 E	1.7	N 32 W	1.7	S 45 W	2.3
500	S 67 W	0.1	N 56 W	1.8	S 49 E	4.2	N 45 W	4.8	S 65 W	5.4
1,000	S 40 E	2.9	N 51 W	4.1	S 17 E	2.2	N 41 W	6.3	S 73 W	9.4
1,500	S 31 W	4.0	N 69 W	6.9	S 87 W	2.5	N 64 W	7.8	N 86 W	9.8
2,000	S 52 W	6.2	N 71 W	11.0	S 60 W	2.9	N 68 W	10.1	N 69 W	13.7
2,500	S 68 W	6.7			S 73 W	7.3	N 83 W	10.1	N 78 W	14.8
3,000	N 86 W	7.8					N 88 W	11.2		
4,000	N 73 W	7.8					S 86 W	12.8		

Altitude (meters) m. s. l.	Salt Lake City, Utah (1,280 meters)		San Francisco, Calif. (60 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (67 meters)		Washington, D. C. (34 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°	
Surface	S 59 E	0.9	N 88 E	1.5	S 70 W	0.9	S 55 E	0.5	N 5 W	1.0
500			E	0.5	S 83 W	4.8	S 69 E	1.0	S 76 W	6.2
1,000			N 52 W	1.6	N 80 W	6.8	S 84 E	2.8	S 78 W	9.3
1,500	S 9 E	3.5	S 85 W	3.4	N 69 W	8.3	S 83 E	1.3	S 82 W	11.5
2,000	S 7 W	3.7	S 72 W	2.7	S 85 W	7.2	N 77 E	0.6	N 88 W	13.2
2,500	S 47 W	4.2	S 84 W	2.9			N 19 E	1.0		
3,000	N 79 W	5.0	N 62 W	4.2			N 58 E	6.6		
4,000	N 81 W	9.3								

TABLE 4.—*Observations by means of kites, captive and limited-height sounding balloons during January, 1930*

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
Mean altitudes (meters), M. S. L., reached during month	2,513	2,442	2,936	1,990	2,089
Maximum altitude (meters), M. S. L., reached and date	[1] 4,270	[2] 4,134	[2] 3,981	[3] 3,077	[4] 3,234
Number of flights made	26	30	39	28	27
Number of days on which flights were made	22	26	30	19	25

[1] 25th. [2] 7th. [3] 5th. [4] 19th.

In addition to the above there were approximately 125 pilot-balloon observations made daily at 53 Weather Bureau stations in the United States.

WEATHER IN THE UNITED STATES

THE WEATHER ELEMENTS

By M. C. BENNETT

GENERAL SUMMARY

January, 1930, was marked by abnormally low temperature, after the first week, that prevailed generally west of the Appalachian Mountains, except in the far Southwest, and the last half of the month was comparatively cold also in the Eastern States.

The area of abnormally low average temperature included the extreme Northwest, the Rocky Mountain region, and most of the Plains and Texas. Here the month was often found to be the coldest January of record or the coldest since 1875. The precipitation was greater than normal over many central and southwestern districts, but mainly less than normal in the eastern and northern districts.

The interior of the country was generally snow-covered during the coldest portion of the month.

PRESSURE AND WINDS

At the beginning of the month low pressure prevailed from Texas to the Great Lakes and westward to the Rocky Mountains and into the far Northwest, with light rain in portions of the Ohio and central Mississippi Valleys, eastern Kansas and Oklahoma, and in a few localities of the far Northwest. During the next few days the rain area overspread the eastern portion of Oklahoma and Texas and districts northward to Canada and eastward to the Atlantic, with generous to heavy falls in some localities, the precipitation turning to snow in the more northern districts. Also, during this period, moderate to generous rain fell in the far Northwest and the North Pacific States. By the morning of the 5th fair weather prevailed over nearly the whole country save in the far Northwest and the North Pacific States. By the next day this precipitation area had extended throughout the Pacific coast region, the Plateau, and northern half of the Rocky Mountain regions, and into the Northwest as far as western Minnesota, the precipitation being generally snow except in the Pacific coast region. This precipitation in southern California was the first, or the first of importance, for several months. At the same time an area of low pressure had moved in from the far Northwest, and by the morning of the 6th was central over southwestern Colorado, with low pressure extending to the upper Lake region, snow having fallen in most sections from the Dakotas westward and southwestward to the Rocky Mountain and Plateau regions. By the next morning, the precipitation area extended from eastern Texas to the Great Lakes and adjacent Canadian Provinces. A low-pressure area had also advanced from the central Pacific coast southeastward into northern Arizona, accompanied by rather heavy precipitation, and by the morning of the 8th was central over New Mexico, with a precipitation area extending from New Mexico and Arizona eastward and southeastward to the Mississippi Valley, and thence northeastward over the lower Lakes and into the St. Lawrence Valley. Generous to heavy falls were reported from many places in the central valleys and Lake region, while throughout the higher elevations the precipitation was snow. The morning of the 9th likewise showed general precipitation, mostly snow, from the central Great Plains States to southern Texas, and northeastward through the central valleys to the Canadian Maritime Provinces.

During the next several days, a series of low-pressure areas, accompanied by moderate to light precipitation, moved from the central Pacific coast, and while they apparently dissipated upon reaching the southern Rocky Mountain region, the areas of cloudy and stormy weather continued to overspread most sections to the Atlantic, the precipitation, because of the unusually cold weather prevailing, being in the form of snow, except in the more southern districts. On the morning of the 16th a precipitation area covered the Plateau and Pacific areas, except portions of Nevada, Arizona, and Utah, which during the next two days had advanced to the Atlantic, the precipitation being generally snow; this was followed by a cold wave and generally fair throughout the East. Another large precipitation area appeared in the Northwest on the 20th, overspread most regions to the south and east, and moved off the Atlantic coast on the 23d; generous snowfall was received in most sections, except in the far South and East, where the precipitation was rain. On the 24th and 25th, little precipitation occurred, except in the vicinity of the Great Lakes and in a few other scattered localities.

On the 26th a low-pressure area appeared in the far Southwest, and during the next few days moved across the southern portion of the country to the Gulf, and thence northeastward. It was accompanied by moderate precipitation from the west Gulf region northeastward. From the 29th to the 31st a low-pressure area developed in the Southwest, and moved along the Gulf coast and up the Atlantic, increasing in intensity as it proceeded northward, accompanied by generous to heavy precipitation, which was rain in the far South, but snow from the Carolinas northward. During the same period rainy weather prevailed throughout the northern half of the Pacific Coast States, extending into Idaho and northern Nevada.

Generally high winds occurred over portions of the Great Lakes region on several dates, with the passing of cyclones over that region, but these caused little damage to property. Over most interior districts the wind movement was light during the colder portion of January, and this considerably reduced the severity of the month for livestock. A full account of the principal windstorms during the month appears as usual at the end of this section, and details of wind direction and barometer data are shown on the usual charts.

TEMPERATURE

For most of the country January was notable for temperatures far from the normal, now considerably above and again decidedly below. "Average January weather" was very uncommon.

The opening week was marked by several abrupt changes of temperature, yet averaged warmer than normal practically throughout the country, especially in the central and northeastern portions. The second week continued mild in the portion east of the Mississippi River, but was decidedly cold over nearly all the remainder, particularly from the middle and upper Missouri Valley westward to the North Pacific States.

The third week brought the culmination of the cold weather for most of the States, and in the country as a whole few weeks of more intense cold are to be found in weather records.

From the Mississippi River westward to the Cascade Mountains and almost to the western limits of Colorado and Texas the week averaged at least 15° colder than normal, and in much of the central and northern Rocky

Mountain region over 30° colder then normal. At Lander, Wyo., the mean temperature of the week was −16°. However, part of Arizona and California and a few Atlantic districts were warmer than normal during this week.

The final 10 days of the month were almost wholly colder than normal in the eastern half, decidedly low temperatures prevailing in the interior districts until about the 27th, but in the western half this period brought a marked transition, for the intense cold continued from the previous week in most States only till the 23d or 24th, then gradually yielded to mild weather which prevailed during the rest of the month.

The chart of departure of the average temperature of the month from the normal shows a decided likeness to the corresponding chart for November, 1929. In each month by far the greater part of the country was considerably colder than normal, with largest departures chiefly in the Rocky Mountains and Plains regions and Texas, while the Atlantic area and part of California were slightly warmer than normal.

The excess in the Atlantic area during January was largest in the South Atlantic States, where it was generally from 2° to 4° per day. The area of excess extended westward to include the upper Ohio Valley and the districts around Lake Ontario. In California a considerable part of the southern half of the State was slightly warmer than normal.

From Idaho, eastern Washington, and western Montana southeastward to south-central Texas the month averaged from 10° to 16° colder than normal. In eight States no colder January is found in the records of the Climatological Service, which cover about 40 years.

To eastward of the strip of greatest abnormality the departure decreased gradually, the immediate Mississippi Valley averaging about 7° below normal in the upper portion and from 2° to 5° in the lower. There was a similar decrease to westward and southwestward, the north Pacific coast averaging about 6° below normal.

The highest temperatures of the month were higher than ordinarily occur in January from the Ohio Valley northeastward, where they occurred mainly on the 9th. In the Gulf States, also, the highest marks were reached on the 9th or within a day or two earlier; but in practically all other parts of the country they occurred during the first five days of the month. The highest of all was 89° in Florida.

The lowest temperatures recorded were as low as or lower than any previous January marks in several States from the middle Rocky Mountains southeastward to the central Gulf, occurring here on the 17th or 18th; at this time the lowest marks of the month were reached in most States from the northern Plateau southeastward to the middle and southern Appalachians, while in many Middle and South Atlantic States they occurred on the 19th or 20th. The lowest mark of all in the United States proper was −57° on the 17th at a point in the mountains of Wyoming. In the Pacific Northwest, the middle and southern Plateau, and many States of the central valleys area the lowest temperatures came on the 21st or 22d, when Oregon, New Mexico, Arkansas, and Illinois surpassed their previous January low marks. Portions of the Lake region recorded their lowest marks of the month on the 26th.

PRECIPITATION

The monthly amounts of precipitation were decidedly large over the central valleys and most of the lower Mississippi Valley, the State of Arkansas averaging more than 9 inches, and several individual stations measuring more than 14 inches. The region of excess included much of the middle and upper Ohio Valley, particularly the northern portions, and most of the Lake region, yet here the excess was mainly small. To the southwestward the area of excess included eastern Oklahoma and extreme eastern Texas.

There was a moderate excess of precipitation over the central Plains and part of the south-central Rocky Mountains, likewise over the central and southern Plateau and in southern California. Much of the Southeast, especially along the coasts, had a slight excess.

From central Alabama northeastward to New England the Appalachian region received less precipitation than normal, likewise the greater part of the coast zone north of Delaware Bay. Central and western Texas and most of southern New Mexico had a similar deficiency; also most northern districts, from Lake Superior to the Pacific coast. The Washington precipitation averaged less than half the normal, and the region of deficiency extended southward in the coast States to central California.

As is likely to be the case in a winter month, heavy rains within brief periods were not numerous, but several points from northwestern Louisiana to southern Illinois did report such rains late in the first decade, Memphis recording almost 8 inches within 36 hours on the 7th and 8th.

SNOWFALL

While January was not notable for heavy falls of snow, yet it was featured by the occurrence of moderate amounts much farther south than they often occur, particularly in Texas and the lower Mississippi Valley, and by the unusual duration of the snow cover in many districts, especially the southern Plains.

From the south-central Rocky Mountain region eastward to the central valleys the month's snowfall was nearly or quite the greatest quantity that ever fell in January, especially in Oklahoma, where the amount was 50 per cent above that of any previous January of record.

In the north-central and southeastern portions of the country the amounts were usually more than the January normals and at the lower elevations of the far West likewise the amounts were unusually great. At Roseburg, Oreg., the snow attained the greatest depth ever recorded, 7.5 inches, and the ground was covered constantly for 14 days.

In the highest portions of the far West the snowfall was frequently less than normal, particularly in Washington. Over the Northeast and much of the Ohio Valley there likewise was somewhat less than the average January snowfall.

The high elevations of the West usually had stored snow indicating improved prospect for stream flow. However, the outlook in several portions, particularly in the Pacific States, had been unfavorable at the close of December, and was not sufficiently improved during January to bring the prospects up to the average for that date.

RELATIVE HUMIDITY AND CLOUDINESS

The average relative humidity for the month was generally above the normal over most districts except throughout the Appalachian region, the southern portion of the east Gulf States, portions of the Lake region, the central Missouri Valley, the far Northwest and most of the southern portion of California, where the average humidity was mainly less than normal.

In the Eastern States and the Gulf States, and generally over the Southwest as far as the southern California coast, cloudy weather seems to have been more prevalent than usual in January; but part of the far Northwest had more clear weather than usual.

SEVERE LOCAL STORMS, JANUARY, 1930

The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Texas (north-central)	7-9					Rain, sleet, and snow.	Overhead wires damaged, traffic delayed, numerous accidents; livestock suffered from severe cold; barley and wheat killed.	Official, U. S. Weather Bureau.
Illinois (southern half), Indiana, and northern Ohio.	8-9					Severe sleet	Power, telephone, and telegraph lines damaged; travel difficult and dangerous; fruit trees broken.	Do.
Cairo, Ill	13	11:48 p. m.	100			Thundersquall	Garage and 2 small houses demolished	Do.
Austin, Tex., and vicinity	19-21					Ice	Travel difficult; temporary suspension of bus traffic.	Do.
Dallas, Tex., and vicinity	21					do	Considerable loss of property	Do.
Port Arthur, Tex. (off coast).	28-29	Night		14		Severe squall	Tug sank; entire crew lost	Do.

RIVERS AND FLOODS

By R. E. SPENCER

In a discussion received too late for inclusion in the December REVIEW, the losses resulting from the moderate Wabash system flood of that month are reported as follows:

Tangible property	$700
Crops, prospective and matured	67, 000
Suspension of business	8, 950
	76, 650
Property saved through Weather Bureau flood warnings	37, 500

In January the only floods of consequence were those in the Wabash-White system of Indiana, and the St. Francis River of Arkansas.

Weather conditions immediately preceding the Wabash-White flood were particularly favorable to its inception. During late December, snow had accumulated in depths ranging from 3 to 6 inches over the White Basin to as much as 18 inches in parts of the upper Wabash Valley. Run-off from this snow cover, already in evidence in the rising streams at the close of December, was considerably increased by the high temperatures of January 1 and 2, and greatly augmented by moderate to heavy but rather irregularly distributed rains on the latter date. The result was that flood stages were reached at all stations on the Wabash proper during the first six days of January. The period from the 2d to the 6th was largely without rainfall, and at stations as far down as Covington, Ind., the river fell somewhat; but beginning with the 6th–7th and continuing (with a 24-hour intermission on the 10th) until the 14th, moderate to heavy rains were again general. In the first four days of this period the rainfall averaged about 2.60 inches over the upper half of the Wabash Valley, and about 2.90 inches over the lower half, while the average over the entire White Basin was slightly in excess of 3.00 inches.

The resultant flood, already of serious character before the cessation of the rain, was substantially checked by the sharp temperature drop of the 15th; but destruction of a severe and extensive character had already occurred. Except at Vincennes on the Wabash, and at Decker on the White, where the stages exceeded by 1.2 feet and 0.2 foot, respectively, the previous high water records, the crests reached this month were lower by substantial amounts than those of the great flood of 1913; but ice gorges were frequent—the two most important of which formed at Mackey Ferry, south of New Harmony, and at Riverton, between Terre Haute and Vincennes; and levee breaks were numerous, and overflow very extensive. Specific details are not yet available of the damage done to farms, highways, bridges, railroad property, etc.; a further discussion on this point will appear in the February REVIEW.

An important feature of the flood was the suffering caused by the pronounced cold which prevailed following the 14th. Refugees, caught in the upper stories of houses or driven from lowland farms and communities, remained isolated, inadequately sheltered, and without food or fuel, for comparatively long periods in which temperatures remained near zero, and during which rescue was rendered especially difficult by the freezing of the surrounding water.

Flood warnings, the issue of which was begun as early as December 26, and continued as necessary, were of a high order of accuracy even in spite of the difficulty imposed by levee breaks. No estimate of their monetary value has yet been made.

The moderate floods of the Lake Erie drainage and the interior rivers of Ohio were caused by the same general weather conditions as was that in the Wabash system. In the Maumee system losses, including that due to suspension of business, amounted to about $35,000; and considerable inconvenience was caused—along the St. Marys, St. Joseph, and lower Auglaize Rivers—by the flooding of homes and business houses.

The floods in Ohio were not particularly important.

Along the Green River of Kentucky and the lower Ohio River the major damage was to matured crops; and a second important loss was that due to damage to farm fences—the recession of water from overflowed lands, occurring after widespread freezing, having left deposits of ice upon the fences heavy enough over many miles of extent to break them down. Losses along the Green amounted to about $23,000, of which $20,000 was in matured crops; and $29,000 was reported saved through the Weather Bureau warnings. The total of losses on the lower Ohio was $178,500, distributed as follows:

Tangible property (chiefly fences)	$36, 600
Matured crops	124, 800
Livestock and other movable property	900
Suspension of business	16, 200
Savings effected by Weather Bureau flood warnings	63, 000

In the St. Francis River Basin, the flooding, which resulted from heavy rainfall in the upper St. Francis and Little River Basins on January 2 and from the 7th to the 14th, was most extensive in Clay, Green, Craighead, and Mississippi Counties of Arkansas. Levee breaks occurred in these counties as follows:

One in the St. Francis River Levee, Arkansas side, near Nimmons, Ark., January 18, width 150 feet; 3 in the St. Francis River Levee, Arkansas side, north of Bertig, Ark., January 15, width 100 feet; 1 in the St. Francis River Levee, Arkansas side, north of Bertig, Ark., January 17, width 150 feet; 1 in Big Lake Levee, 10

miles west of Blytheville, Ark., and 6 miles south of the Missouri line, final width about 300 feet.

The total estimated overflow from these and other causes was 126,500 acres—11,500 from the Clay and Green County levee breaks, 10,000 in Craighead County from overflowing drainage ditches, 40,000 in Craighead County from overflow from St. Francis Lake, and 65,000 in Mississippi County from the Big Lake Levee break.

Owing to the severe cold which prevailed during the flood, considerable distress was experienced by refugees—many of whom were marooned for several days. It is estimated that 800 families were forced by the overflow to leave their homes.

Of the remaining floods of this month, that in the Black and White Rivers of Arkansas caused little loss except the costs of removing stock from lowlands, securing rafts and boats, repairing levees and highways, and replacing a few small bridges; that in the Mississippi was of no especial importance; and that in the Ouachita resulted in little or no direct damage but some inconvenience and loss on account of suspended business. Report on the Tallahatchie River flood will appear in the REVIEW for next month.

Flood stage and crest data are given in the following table:

[All dates in January unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
Pedee:	Feet			Feet	
Mars Bluff, S. C	17	18	25	18.3	21
Poston, S. C	18	22	27	18.9	24
Black: Kingstree, S. C	12	24	26	12.2	25
Santee:					
Rimini, S. C	12	17	(1)	13.9	23
Ferguson, S. C	12	(2)	7	21.0	Oct. 7
		17	(1)	13.3	22-27
EAST GULF DRAINAGE					
West Pearl: Pearl River, La	13	26	31	14.0	27
GREAT LAKES DRAINAGE					
Maumee:					
Fort Wayne, Ind	15	2	19	22.2	15-16
Napoleon, Ohio	10	3	4	10.0	3-4
		9	10	11.0	9-10
		14	18	15.5	16
St. Joseph: Montpelier, Ohio	10	2		12.6	3
		7		12.2	8
		14		11.8	16
Sandusky:					
Upper Sandusky, Ohio	13	3	3	13.2	3
		8	9	15.0	9
		13	14	14.1	14
Tiffin, Ohio	7	9	10	7.6	10
		13	15	9.0	14
Fremont, Ohio	11	9	10	12.6	9
		13	16	14.4	15
MISSISSIPPI DRAINAGE					
Allegheny: Lock 5, Freeport, Pa	24	14	14	24.4	14
Ohio:					
Dam 47, Newburgh, Ind	35	10	23	39.0	17
Evansville, Ind	35	10	24	39.9	17-18
Dam 48, Cypress, Ind	35	11	24	39.6	18
Dam 49, Uniontown, Ky	35	11	27	43.6	21
Shawneetown, Ill	35	11	27	45.8	19-21
Dam 50, Fords Ferry, Ky	35	11	28	46.3	19
Dam 51, Golconda, Ill	38	14	25	41.6	19
Shenango: Sharon, Pa	9	13	16	10.4	14-15
Muskingum: McConnelsville, Ohio	22	14	17	24.3	15
Tuscarawas: Coshocton, Ohio	8	4	4	8.0	4
		9	18	14.0	15
Walhonding: Walhonding, Ohio	8	2	4	10.4	3
		8	16	13.0	9
Scioto:					
Larue, Ohio	11	2	3	11.8	3
		8	15	13.9	13
Prospect, Ohio	10	4	4	10.0	4
		9	17	13.9	15
Bellpoint, Ohio	9	9	10	10.1	10
		13	15	9.7	13
		20	20	9.0	20
Circleville, Ohio	10	3	4	10.9	4
		9	16	14.7	10
Chillicothe, Ohio	16	10	17	20.4	15
Olentangy: Delaware, Ohio	9	8	10	11.5	9
		13	14	10.2	13
MISSISSIPPI DRAINAGE—continued					
Miami:	Feet			Feet	
Sidney, Ohio	12	8	8	12.2	8
		13	14	12.2	13
Middletown, Ohio	15	8	11	18.0	10
		13	14	16.6	14
Stillwater: Pleasant Hill, Ohio	13	9	9	13.5	9
Green:					
Lock No. 4, Woodbury, Ky	33	10	12	34.9	11
Lock No. 2, Rumsey, Ky	34	10	22	39.6	16
Wabash:					
Bluffton, Ind	11	4	4	11.0	4
		10	17	15.2	14
Logansport, Ind	15	14	16	17.8	15
Lafayette, Ind	13	2	19	24.0	16
Covington, Ind	16	2	27	27.7	17
Terre Haute, Ind	16	3	26	24.0	16
Vincennes, Ind	14	6	27	25.2	17
Mount Carmel, Ill	16	4	29	27.1	17
Tippecanoe: Norway, Ind	6	1	16	6.4	14
White: Decker, Ind	18	8	26	29.0	17
White, East Fork:					
Seymour, Ind	10	8	17	14.5	10
Williams, Ind	10	11	21	20.6	14
Shoals, Ind	20	10	22	32.6	15
White, West Fork:					
Anderson, Ind	12	8	15	14.9	14
Noblesville, Ind	14	9	16	16.9	15
Indianapolis, Ind	18	15	15	18.3	15
Elliston, Ind	19	3	20	27.9	15
Edwardsport, Ind	15	3	23	20.3	14, 18
Mississippi:					
New Madrid, Mo	34	17	23	35.2	20
Vicksburg, Miss	45	29	Feb. 6	45.7	Feb. 3
Illinois:					
Morris, Ill	13	22	25	13.4	23-24
Peru, Ill	14	4	(1)	18.0	19-20
Havana, Ill	14	23	31	14.1	25-30
Beardstown, Ill	14	30	(1)		
Pearl, Ill	12	25	(1)	13.6	29-30
Meramec:					
Steelville, Mo	12	15	15	12.5	15
Pacific, Mo	11	13	17	19.0	16-17
Valley Park, Mo	14	13	18	23.6	16
Bourbeuse: Union, Mo	12	15	16	14.0	16
St. Francis:					
Chaonia, Mo	22	8	10	24.4	8
		13	17	34.7	15
Fisk, Mo	20	8	20	26.4	16
St. Francis, Ark	18	8	27	26.5	18
Marked Tree, Ark	17	15	(1)	18.6	[1] 27
Arkansas: Yancopin, Ark	29	13	(1)	35.0	27-30
Petit Jean: Danville, Ark	20	10	16	22.3	14
White:					
Calico Rock, Ark	18	14	15	20.8	14
Batesville, Ark	23	13	17	28.0	15
Newport, Ark	26	14	20	29.7	17
Georgetown, Ark	22	12	31	26.5	20-21
De Valls Bluff, Ark	24	14	31	26.8	22-23
Clarendon, Ark	30	19	29	31.0	23-24
Black:					
Leeper, Mo	11	14	14	11.2	14
Williamsville, Mo	11	14		13.2	15
Poplar Bluff, Mo	14	14	17	17.4	16
Corning, Ark	11	4	31	14.8	20
Black Rock, Ark	14	8	31	23.6	15
Cache: Patterson, Ark	9	9	(1)	11.5	15
Tallahatchie: Swan Lake, Miss	25	14	(1)	31.9	27-29
Ouachita:					
Arkadelphia, Ark	12	8	15	20.4	10
Camden, Ark	30	11	22	37.5	17

[1] Continued at end of month. [2] Continued from last month.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, JANUARY, 1930

By J. B. KINCER

General summary.—The month of January, 1930, was noted for its severe weather, especially during the latter half in the Northwest, where temperatures for the two weeks ending on the 28th averaged 24° to 33° below normal. Early in the month seasonal farm work made fairly good advance and moisture conditions were generally satisfactory over the eastern part of the country, but portions of the West were dry. Winter grain fields were generally bare of snow, but toward the middle of the month good snows occurred. The warm weather the first part of the month aided planting and replanting of truck in the South, and improvement continued through the first part of the second decade. The latter part was noteworthy by reason of two severe cold waves which

overspread the Southwest, bringing record-breaking low temperatures to many parts, especially in Texas, where it was the most severe cold wave in 30 years. There was considerable damage to tender truck in this area as well as some injury to citrus in the lower Rio Grande Valley, but the extreme Southeast escaped severe harm and the cold did not penetrate to the Florida Peninsula. Winter grain crops were largely well protected during the severe weather, but there were some local reports of damage where there was no snow cover. Fruit buds were also reported injured, especially peaches in the Ozark region and the Ohio Valley. Outside operations were generally at a standstill due to the cold and mostly unfavorable conditions.

Small grains.—During the first part of the month the general condition of winter wheat was mostly satisfactory, except for local reports of flooding and heaving in the Ohio Valley. Good snows occurred toward the middle of the month, but some areas were bare, expecially in western Kansas and Texas; there were some reports of soil blowing in the former State. A light to ample snow blanket covered the far Northwest, while moisture was beneficial in other parts of the West.

During the severe weather of the last part of the month winter grain crops were mostly well protected by an adequate snow cover, except for some bare fields in the southwestern belt and reports of ice in Missouri and Oklahoma. There was much winterkilling in Texas, while oats were largely killed in Arkansas; much wheat was frozen to the ground in western Kansas. In the Southeast and East winter grains were in good condition, but in the Northwest there was some apprehension because of the scanty snow cover.

Miscellaneous crops.—Livestock conditions were generally satisfactory during the first part of the month, with some range open in the northern Rocky Mountain region, and range and water conditions were satisfactory in the Southwest. Toward the middle part of the month the wintry weather over the Great Plains and northern Rocky Mountains caused considerable deterioration of stock, with heavy feeding necessary. Additional snows extended the winter range in Colorado, while precipitation was beneficial in some western parts of the country.

The low temperatures and generally severe weather caused considerable shrinkage of livestock during the latter part of the month, but there were no widespread reports of losses. Heavy feeding was necessary generally over the great western grazing area, although the range was partly open locally, permitting some ranging. Shed lambing began during the latter part of the month in the Northwest, with good results in Idaho, but serious losses in Oregon.

Much truck was planted and replanted in the southern districts during the first part of the month, but there were reports of only fair condition of those crops which escaped the December freezes. The cold waves during the latter part of the month caused extensive damage to truck in the southern area, especially in Texas, where injury was reported south to the lower Rio Grande Valley. There were no extensive reports of harm in the more southeastern areas and the Florida Peninsula was generally free of damaging cold. Satisfactory conditions prevailed in the western trucking portions. Sugar cane grinding in Louisiana was abandoned about the middle of the month due to continued deterioration of the standing cane as well as acidity and decreasing sucrose. There were reports of extensive injury to peach buds in the Ozark regions of Missouri and Arkansas, with apple trees injured in Utah. Satsuma trees in Alabama that were not in healthy condition were also damaged or killed, while there was some injury to citrus in Texas. Citrus were good in most other portions; picking navels and avocados had been suspended in California due to rains, but this work was resumed at the close of the month.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The weather over the North Atlantic Ocean during January presented some unusual features. Gales were comparatively rare west of the fortieth meridian, as they were not reported on more than three days in any 5° square in that region. On the other hand, the number of days on which they occurred over the eastern section of the steamer lanes was considerably above the normal and exceptionally severe and protracted disturbances prevailed during the second and third decades of the month.

According to press reports, the Dutch S. S. *Veendam* arrived in Halifax, Nova Scotia, on February 5, three days overdue, having encountered on January 30, what Capt. R. W. Braun described as a hurricane, and one of the worst he ever experienced. The vessel was subjected to considerable damage, and two passengers, as well as five members of the crew were injured.

As shown in Table 1, large negative pressure departures still prevailed at the three land stations on the British Isles, the pressure at Lerwick and Valencia remaining below normal during nearly the entire month, while at London barometric readings ranging from 30.28 to 30.01 were reported during the period from the 16th to 22d.

The number of days on which fog was reported in different localities was as follows: Along the American coast between the thirtieth and forty-fifth parallels, from 5 to 8 days; over the Grand Banks, from 6 to 7 days; in the Gulf of Mexico from 1 to 4 days. The steamer lanes east of the fortieth meridian were unusually free from fog, as it was not reported on more than 2 days in any 5° square in that region.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian), North Atlantic Ocean, January, 1930*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.29	(1)	29.96	15th	28.51	21st.
Belle Isle, Newfoundland	29.93	[2] +0.13	30.50	12th	29.16	16th.
Halifax, Nova Scotia	30.21	[2] +0.23	30.88	12th	29.62	29th.
Nantucket	30.23	[2] +0.18	30.72	5th	29.78	15th.[4]
Hatteras	30.21	[3] +0.07	30.68	5th	29.68	30th.
Key West	30.11	[3] 0.00	30.24	4th [4]	29.96	16th.[4]
New Orleans	30.21	[2] +0.05	30.62	4th	29.86	14th.
Cape Gracias, Nicaragua	29.95	[2] −0.03	29.98	4th [4]	29.90	2d.[4]
Turks Island	30.16	[2] +0.11	30.24	19th [4]	30.06	8th.
Bermuda	30.25	[2] +0.09	30.48	2d [4]	29.92	31st.
Horta, Azores	30.25	[2] +0.15	30.62	1st	29.38	15th.
Lerwick, Shetland Islands	29.37	[2] −0.33	30.19	16th	28.48	12th.
Valencia, Ireland	29.53	[2] −0.37	29.91	2d	28.49	31st.
London	29.78	[2] −0.22	30.28	16th	29.14	11th.

[1] No normal available.
[2] From normals shown on Hydrographic Office pilot charts, based on observations at Greenwich mean noon, or 7 a. m., seventy-fifth meridian time.
[3] From normals based on 8 a. m. observations.
[4] And on other date or dates.

From the 2d to 8th, moderate to whole gales occurred over the eastern section of the steamer lanes, and during the same period winds of force 7 and 8 were reported by a

number of vessels between the Bermudas and forty-fifth parallel.

About the 5th, a small cyclonic disturbance developed in approximately latitude 22° 30′ N., longitude 56° W., whence it moved rather slowly westward during the ensuing several days. By the morning of the 9th it had reached latitude 27° 30′ N., longitude 68° W., and was affecting a number of vessels in that locality. Vessels near the center that have thus far reported to the Weather Bureau experienced moderate to strong gales and high sea. The lowest pressure reported was 29.54 inches. The disturbance, with diminishing intensity, continued to move westward on a course inclining somewhat to the southward and passed through the Florida Strait into the Gulf of Mexico on the 12th–13th. Here, as a shallow depression, it turned northward along the Atlantic seaboard and on the 15th merged with a western continental disturbance in the Gulf of St. Lawrence.

From the 9th to 16th a series of severe disturbances prevailed over an extensive region east of the forty-fifth meridian, and on the 15th and 16th the storm area extended nearly to the thirtieth parallel, with winds of hurricane force prevailing between the Azores and thirty-fifth meridian as shown by report in table.

From the 18th to 23d, moderate to strong gales were reported over the middle and eastern sections of the steamer lanes, with winds of force 10 and 11 on the 22d and 23d.

On the 26th and 27th northerly to northwesterly gales occurred in the vicinity of the Straits of Gibraltar, and on the latter date a LOW was central near 50° N., 30° W., that afterwards developed into the very severe disturbance that swept the eastern section of the ocean during the remainder of the month. Charts VIII to XI cover the period from the 28th to 31st, inclusive; Chart X also shows the disturbance off Hatteras on the 30th, which was the only one of any intensity reported from that region during the month.

The New York Maritime Register reports that the tug *Edgar F. Coney* was sunk in the Gulf of Mexico on January 31, with a loss of 13 lives. An area of high pressure spread over the Gulf on that day but up to time of writing no reports of heavy weather in that locality have been received, although the conditions were favorable for a "norther."

OCEAN GALES AND STORMS, JANUARY, 1930

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
North Atlantic Ocean			° ′	° ′				Inches					
City of Flint, Am. S. S.	Dundee	Philadelphia	58 42 N	10 30 W	Jan. 1	10 p., 1	Jan. 4	29.46	SW	W, 8	NW	NW, 9	SW-W.
Exbrook, Am. S. S.	Gibraltar	New York	38 36 N	65 45 W	3	10 p., 3	4	29.89	SW	SW, 10	NW	SW, 10	SW-WNW.
Wymeric, Br. S. S.	Shellhaven	Curacao	45 32 N	15 02 W	4	Noon, 4	5	29.44	SW	NW, 10	NW	SW, 11	
City of Flint, Am. S. S.	Dundee	Philadelphia	57 14 N	22 44 W	6	3 a., 7	12	29.90	WSW	W, 11	W	—, 11	Steady.
Minnetonka, Br. S. S.	New York	London	49 20 N	19 53 W	10	Noon, 10	11	29.25	SW	WNW	WNW	—, 10	WSW-WNW.
Edgehill, Am. S. S.	Houston	do	47 48 N	31 30 W	11	6 p., 11	12	29.38	WNW	WNW	W	W., 10	Var.
Am. Press, Am. S. S.	Manchester	New Orleans	50 22 N	7 00 W	10	6 a., 11	12	29.11	SW	W, 11	WNW	W., 12	
Orla, Nor. S. S.	Rotterdam	Boston	50 10 N	5 05 W	10	4 p., 12	14	28.90	SW	WSW, 11	SSW	W., 12	SW-W-SW.
Gonzenheim, Ger. S. S.	Emden	do	34 02 N	39 50 W	12	10 p., 14	15	29.95	SW	NW, 9	NW	WSW, 10	WSW-NW.
Independence Hall, Am. S. S.	Havre	New York	39 06 N	32 40 W	7	—, 15	16	29.46	W	NW, 12	NNW	NW, 12	
President Wilson, Am. S. S.	Marseille	do	42 25 N	32 30 W	14	6 a., 15	16	28.87	W	WNW	NW	—, 12	Steady.
Tynefield, Br. M. S.	River Tyne	Baytown	48 25 N	12 00 W	16	10 p., 16	17	29.18	SSE	SSE, 12	SSE	SSE, 12	S-SSE-SSW.
President Roosevelt, Am. S. S.	Cherbourg	New York	49 19 N	19 30 W	18	10 a., 18	22	29.47	SW	SW, 8	W	W, 11	SW-W.
Berlin, Ger. S. S.	Bremerhaven	do	49 38 N	30 24 W	21	—, 21	22	29.28	W	W, 10	W	W, 10	
Muenchen, Ger. S. S.	New York	Southampton	49 09 N	16 09 W	23	11 a., 23	23	28.86	S	S, 12	S	S, 12	S-WSW.
Saco, Am. S. S.	Rotterdam	New York	40 51 N	26 34 W	25	—, 25	25	29.39	NW	NW	NW	—, 10	Steady.
Scantic, Am. S. S.	Naples	Tampa	34 12 N	11 20 W	25	1 a., 26	27	29.67	WSW	NW, 10	N	NW, 10	WSW-SW-NW.
Dresden, Ger. S. S.	Cobh	New York	50 08 N	23 55 W	27	4 p., 27	29	29.10	S	SW, 8	WNW	W, 11	
Cabo Espartel, Span. S. S.	Malaga	do	30 00 N	67 00 W	28	8 a., 28	30	30.01	N	N, 5	ENE	ENE, 10	
West Cobalt, Am. S. S.	New Orleans	Liverpool	49 34 N	20 16 W	27	Mdt., 28	29	29.42	WSW	W, 9	W	WSW, 10	Steady.
Quaker City, Am. S. S.	Dundee	Philadelphia	58 20 N	30 10 W	27	2 a., 29	29	28.90	S	SE, 8	N	SE, 10	
Milwaukee, Ger. S. S.	Bishops Rock	New York	49 12 N	22 08 W	28	11 a., 29	31	29.34	WSW	W, 9	SE	W, 12	WSW-WNW.
El Almirante, Am. S. S.	New Orleans	do	33 00 N	77 00 W	29	11 a., 29	31	30.08	NNE	NNE, 8	NNW	NW, 10	
George Washington, Am. S. S.	Cobh	do	47 08 N	40 25 W	30	4 a., 30	31	29.53	WSW	WSW, 10	NW	W, 12	SE-WSW.
Dresden, Ger. S. S.	do	do	47 26 N	37 29 W	30	Noon, 30	31	29.23	W	W, 10	WNW	W, 12	
Veendam, Du. S. S.	Rotterdam	do	49 25 N	33 20 W	26	11 a., 30	30	28.84	ENE	W, 9	WNW	WNW, 12	S-W.
Lord Kelvin, Br. S. S.	Halifax	Cable repairs	43 22 N	56 25 W	31	1 a., 31	31	30.04	ENE	ENE, 8	NNW	E, 10	E-NNW.
Balsam, Am. S. S.	Cork	New York	45 16 N	23 07 W	31	Noon, 31	Feb. 1	28.98	NW	NW, 12	W	NW, 12	NW-W.
Bellepline, Am. S. S.	Antwerp	do	49 30 N	21 04 W	28	8 a., 31	1	28.32	S	WSW, 11	WNW	NW, 12	WSW-NW.
West Harcuvar, Am. S. S.	Bremen	Boston	44 02 N	12 09 W	30	8 p., 30	1	29.61	SW	SW, 9	W	W, 11	SW-W.
North Pacific Ocean													
Carlier, Belg. S. S.	Muroran	Vancouver	42 01 N	178 23 W	1	—, 2	2	29.65	SSE	S, 9	S	S, 12	
Siberia Maru, Jap. S. S.	Victoria	Yokohama	47 40 N	165 40 E	1	Mdt., 2	3	28.92	ESE	SW, 7	WSW	SSW, 12	SSW-WSW.
Chief Capilano, Br. S. S.	Seattle	do	45 13 N	159 10 E	1	8 a., 1	3	28.15	E	ENE, 8	WNW	W, 12	ENE-N.
Golden Dragon, Am. S. S.	San Francisco	Shanghai	48 00 N	142 00 W	1	—, 1	4	29.70	WSW	SW, 9	NW	WNW, 10	SW-W.
Kaisho Maru, Jap. S. S.	Muroran	Vancouver	47 10 N	160 10 E	1	4 p., 4	5	29.14	NNW	W	SW	W, 11	6 pts.
Northwestern, Am. S. S.	Seattle	Seward	58 41 N	139 20 W	2	6 p., 2	3	29.99	NE	NE, 7	NE	NE, 9	Steady.
Pres. Taft, Am. S. S.	San Francisco	Yokohama	34 30 N	156 05 E	2	10 p., 3	4	29.12	WNW	SW, 10	NNW	SW, 10	SW-NW.
San Rafael, Am. S. S.	Portland	Canal Zone	12 30 N	94 30 W	3	6 p., 4	4	29.76	NE	NE, 9	N	NNW, 9	
Pres. McKinley, Am. S. S.	Victoria	Yokohama	49 35 N	178 45 W	3	4 a., 5	6	28.74	SW	WSW	W	WSW, 11	SW-WSW.
Nevada, Am. S. S.	Manila	San Francisco	39 00 N	175 45 E	4	6 p., 4	4	29.54	S	S, 11	W	S, 11	S-SSW.
Akagisan Maru, Jap. M. S.	Yokohama	do	48 44 N	179 25 W	4	Noon, 4	4	28.99	SE	S, 10	SW	S, 11	SE-SW.
Pres. Lincoln, Am. S. S.	do	do	26 20 N	149 30 W	4	2 p., 4	6	29.75	ENE	ENE	E	E, 9	ENE-E.
Lubrico, Am. S. S.	Richmond	Honolulu	35 49 N	129 45 W	6	4 a., 6	6	30.06	NW	NW, 8	N	NW, 9	
Golden Dragon, Am. S. S.	San Francisco	Shanghai	51 02 N	165 15 W	6	—, 7	7	29.74	SSE	SSE, 9	SW	SSE, 9	Steady.
Pres. Cleveland, Am. S. S.	Yokohama	Victoria	49 10 N	179 30 W	7	11 p., 7	7	28.67	E	E, 5	SW	SSW, 10	
Kurohime Maru, Jap. S. S.	Wakamatsu	Grays Harbor	49 36 N	179 25 W	8	7 p., 10	11	28.45	SW	ESE, 9	S	ESE, 11	SE-ESE.
Sierra, Am. S. S.	Pago Pago	San Francisco	35 40 N	129 20 W	9	1 a., 9	9	30.09	NW	NW, 7		—, 10	Steady.
Tecumseh, Br. S. S.	San Pedro	Osaka	32 45 N	155 03 E	9	Noon, 9	9	29.70	W	W, 9	WNW	W, 10	W-WNW.
Mauna Ala, Am. S. S.	Seattle	Honolulu	31 25 N	150 50 W	9	1 p., 10	10	29.80	E	ESE, 10	SSE	E, 10	E-SSE.
Tahchee, Br. S. S.	Shanghai	San Pedro	38 50 N	162 27 E	9	6 p., 9	12	29.07	NE	NNE, 9	WNW	N, 10	NNE-N.
Calawaii, Am. S. S.	Honolulu	Los Angeles	30 06 N	126 37 W	10	Mdt., 10	11	29.88	WNW	WNW, 9	NW	WNW, 9	WNW-NW.

OCEAN GALES AND STORMS, JANUARY, 1930—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
North Pacific Ocean—Continued			° ′	° ′				Inches					
Courageous, Am. M. S.	Manila	Shanghai	20 17 N	120 55 E	11	1 p., 11	13	30.02	NNE	NNE, 6	NE	NNE, 9	
Emp. of Asia, Br. S. S.	Vancouver	Honolulu	31 35 N	148 54 W	11	2 p., 15	16	29.30	S	WSW, 8	W	W, 9	WSW-W.
Lubrico, Am. S. S.	Richmond	do	28 02 N	146 45 W	9	Noon, 10	10	29.88	E	SE, 9	SSE	SE, 9	SE-SSW.
Do	do	do	23 00 N	154 30 W	12	8 p., 12	13	29.68	SW	SW, 9	NW	NW, 10	SW-NW.
Kaisho Maru, Jap. S. S.	Muroran	Vancouver	49 50 N	151 00 W	12	2 a., 15	16	29.57	SE	E	E	E, 12	4 pts.
Hawaii Maru, Jap. S. S.	San Pedro	Yokohama	30 05 N	175 00 W	12	Noon, 15	17	29.57	NNW	NW, 8	NW	NW, 9	NW-WNW.
Wilhelmina, Am. S. S.	Honolulu	Seattle	45 08 N	131 16 W	13	8 a., 14	14	29.60	NW	E, 7		N, 9	
Tahchee, Br. S. S.	Shanghai	San Pedro	38 20 N	172 13 W	13	5 a., 13	14	28.96	W	W, 10	NW	NW, 11	W-NW.
Cingalese Prince, Br. M. S.	San Pedro	Yokohama	29 37 N	175 40 E	13	4 a., 14	14	29.85	WSW	WSW, 8	NW	NW, 9	WSW-W.
Seattle, Am. S. S.	Hakodate	Seattle	50 20 N	152 26 W	13	1 p., 16	16	28.81	E	E, 8	S	NE, 11	E-ENE.
Glentworth, Br. S. S.	San Pedro	Kobe	33 36 N	170 58 W	13	—, 16	21	29.08	N	WSW, 10	SW	W, 12	
Kurohime Maru, Jap. S. S.	Wakamatsu	Grays Harbor	50 00 N	158 30 W	14	1 p., 14	15	29.16	E	E, 7	E	E, 11	ESE-E.
Silvercedar, Br. M. S.	Sourabaya	San Francisco	33 22 N	164 00 W	14	11 p., 16	17	29.09	WSW	W, 8	WSW	WNW, 9	SW-W.
Pres. Harrison, Am. S. S.	San Francisco	Honolulu	27 49 N	147 00 W	15	10 a., 15	16	29.54	SW	SW, 8	NW	W, 10	SW-W.
Tahchee, Br. S. S.	Shanghai	San Pedro	38 07 N	158 55 W	16	6 p., 16	16	29.07	SSE	SSE, 10	SSW	SSE, 10	SSE-S.
Wilhelmina, Am. S. S.	Seattle	Honolulu	47 50 N	125 45 W	17	8 a., 17	17	29.54	E	E, 8	E	E, 9	E-ESE.
Cambrai, Am. S. S.	Manila	San Francisco	34 12 N	179 06 E	17	2 a., 17	17	29.25	WNW	WNW, 8	WNW	WNW, 11	Steady.
Choyo Maru, Jap. S. S.	Uraga	Coos Bay	47 09 N	168 40 E	18	4 p., 19	20	28.45	WSW	W, 7	SW	WSW, 10	WSW-W.
Toyama Maru, Jap. S. S.	Yokohama	Victoria	49 41 N	166 00 W	20	Mdt., 20	21	29.18	SE	ESE, 9		ESE, 9	ESE-SE.
Glentworth, Br. S. S.	San Pedro	Kobe	33 10 N	169 50 E	24	8 a., 24	24	29.52	S	N, 10	W	WNW, 12	WSW-NW.
Do	do	do	33 08 N	164 33 E	25	2 p., 25	26	29.52	S	S, 10	WNW	SW, 11	SW-NW.
Montana, Am. S. S.	Yokohama	Seattle	49 40 N	178 40 E	25	10 a., 26	26	29.32	ESE	ESE, 9	SE	ESE, 9	ESE-SE.
Modjerkoto, Du. S. S.	Balik	Los Angeles	33 20 N	155 20 W	28	2 p., 28	28	29.51	W	W, 8	SW	NW, 9	NW-WNW.
Tatsuno Maru, Jap. S.S.	Yokohama	San Francisco	40 40 N	152 29 E	29	4 p., 30	31	28.72	SE	SW, 8	SW	SSE, 9	
Ibukisan Maru, Jap. S. S	do	do	39 58 N	150 25 W	29	Noon, 30	31	28.78	SSE	SW, 9	W	W, 10	
Montana, Am. S. S.	do	Seattle	50 29 N	159 48 W	30	Noon, 31	31	28.76	N	—, 8	NW	—, 9	N-NW.
Pres. Taft, Am. S. S.	do	do	44 00 N	157 00 E	30	6 a., 30	31	29.18	E	SE, 11	ESE	SE, 11	E-SE.

NORTH PACIFIC OCEAN

By Willis E. Hurd

A very unusual average pressure condition characterized the weather of the central and northern portions of the North Pacific Ocean during January, 1930. The Aleutian cyclone, which ordinarily appears centered over the Gulf of Alaska or nearly along the chain of the Aleutian Islands, now lay farther southward in midocean. To its eastward the California-Pacific anticyclone, although at times occupying its normal position, was for the most part restricted to extreme eastern and northeastern waters. The average oceanic maximum of about 30.30 inches covered the upper eastern part of the Gulf of Alaska and British North America. The average barometer at Juneau and Kodiak was, respectively, 0.56 and 0.45 inch above the normal. This anticyclonic condition gave the lower Alaskan coast, as exemplified by Juneau, the clearest skies on record for any month. Over the central and west-central parts of the ocean, between latitudes 30° and 50° N., the low pressure was associated with extraordinary meteorological activity, marked by high winds, frequent rains, snows, and hail squalls, departures from the usual prevailing winds, and the extension of abnormally low monthly pressures into tropical latitudes. At Honolulu the negative pressure departure was slightly more than a tenth of an inch. At Midway Island the average pressure was 29.89 inches, which may be compared with the value of 29.81 inches in January, 1916, when the absolute minimum of record at that station occurred.

In the Far East more normal conditions prevailed. Several minor cyclones appeared in various parts of the sea, but during most of the month high pressure overlay China and the adjoining coastal waters, with the result that the northeast monsoon prevailed from the Eastern to the China Sea with few intermissions.

Barometric data for several island and coast stations in west longitudes, including Point Barrow on the Arctic Ocean, are given in the following table:

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean and adjacent waters, January, 1930*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	Inch	Inches		Inches	
Point Barrow [1] [2]	30.25		30.70	27th	29.50	6th.
Dutch Harbor [1]	29.79	+0.15	30.58	2d	29.14	17th.
St. Paul [1]	29.82	+0.13	30.60	27th [3]	29.00	13th.
Kodiak [1]	30.20	+0.56	30.64	26th	29.12	31st.
Midway Island [1] [4]	29.89	−0.11	30.16	3d	29.50	29th.
Honolulu [5]	29.89	−0.12	30.09	31st	29.72	28th.
Juneau [5]	30.33	+0.45	30.74	14th	29.18	31st.
Tatoosh Island [5] [6]	30.05	+0.11	30.57	20th	29.36	4th.
San Francisco [5] [6]	30.04	−0.05	30.36	21st	29.65	10th.
San Diego [5] [6]	30.03	−0.03	30.29	22d	29.75	11th.

[1] P. m. observations only.
[2] For 26 days.
[3] And on 28th.
[4] For 30 days.
[5] A. m. and p. m. observations.
[6] Corrected to 24-hour mean.

Few, if any, months since our special studies of the weather of the North Pacific Ocean began have been so generally stormy as was January, 1930, winds of storm to hurricane force in themselves occurring on at least 11, and probably more, days. On the American-Hawaiian routes, though none of the deep cyclones characteristic of more westerly areas occurred there, several active depressions formed and the accompanying gales of force 8 to 10 were encountered on at least 13 days out of the first 16 of the month. These were largely experienced some 10 to 20 degrees northeast of the islands, the frequency lessening considerably thence toward the California coast. In the vicinity of Hawaii gales occurred on the 13th and 15th, being of force 10 from the northwest in the lee of Oahu Island on the 13th. At Tatoosh Island, Wash., winds of force 11 were registered at the Weather Bureau station on the 16th and 17th, and lesser high velocities on several other days. Over the eastern part of the ocean there were fewer days with gales on the upper than on the lower routes this month. The easternmost gales to attain hurricane force occurred on the 15th near the fiftieth parallel between 150° and 160° west longitude. This was in the region of greatest pressure gradient between the Alaskan anticyclone and the extensive mid-Pacific cyclone of that date.

The area of most intense and longest-sustained storm energy was embraced between latitudes 30° and 50° N., and longitudes 170° W. and 155° E. Here the Aleutian Low largely concentrated, and into this vast expanse of depressed barometer poured the most of the moderate disturbances which originated in Asia and in Asiatic waters. Here on no less than 10 days winds of major intensity—force 11 to 12—were developed, beside whole gales on several days, and fresh to strong gales almost daily throughout the month. Here also individual pressure readings were made at times that were practically an inch lower than the minima of about 29 inches observed at either Dutch Harbor or St. Paul in the heart of the normal winter low pressure region. Between longitudes 180° and 170° W. winds of storm to hurricane force were encountered on the 2d, 4th, 10th, 13th, 16th, and 17th, and west of 180° on the 1st, 2d, 4th, 24th, 25th, and 30th. The first four days of January formed an exceptionally stormy period, the severe weather covering an immense area. From the 13th to 17th another period of sustained severity occurred, this one irregularly affecting half the ocean, but concentrating its greatest energy between the thirtieth and fortieth parallels north of Midway Island. After the 25th the weather moderated in east longitudes, although on the 29th and 30th wind forces of 10 or 11 were reported from small areas at steaming distances of a day or two east of Japan.

Strong northeast monsoons of force 7 to 9 were reported on several days along the entire China coast.

In the Gulf of Tehuantepec northers of force 8 to 9 were reported by seamen on the 3d, 4th, 5th, 23d, 24th, 30th, and 31st. At the port of Salina Cruz Tehuantepecers of force 9 were reported on the 3d, and of force 10 on the 4th, 5th, 10th, 23d, and 30th.

The unwonted pressure alinement over the Pacific caused the prevailing wind at Honolulu to be from the north for the first time on record for any month since the establishment of the station in 1904. The maximum velocity was at the rate of 35 miles an hour from the southwest on the 15th, during the prevalence of the low pressure wave which covered the greater part of the ocean.

Fog occurred on only two or three days over the western part of the ocean. Over the eastern part fog was scattered, but formed on three to five days in some localities along the northern and central routes. On the coast of the United States there was a considerable decrease from that of December, the occurrence off middle California falling from about 50 to about 20 per cent, and from about 25 per cent to 10 or lower north and south of this central coastal area.

PAMPERO

The following account of a pampero which occurred on January 1, 1930, at the mouth of the Parana River, Paraguay, was furnished to the Weather Bureau by Mr. W. A. Farrell, second officer and observer of the British tanker *San Macedonio*, Capt. J. W. Tozer, Rio de Janeiro to San Pedro, via Buenos Aires:

> January 1, 1930, 4 p. m., civil time, whilst proceeding up the Parana River about 10 miles from where it enters the River Plate, the sky was observed to be very heavy with thundershowers to the west. Thunder and lightning were observed for one hour before the pampero struck the ship.
>
> The pilot advised all awnings to be taken in, and at 4 p. m. with a rush and a roar from the SSE. the wind and rain came at hurricane force, it being so strong that it steered the ship toward the weather bank of the river (this being a tanker with the funnel aft, the funnel acted as a sail and caught most of the wind above the trees). The engines were put full astern and the anchor let go, and the ship swung across the river head to wind, there being plenty of room at this part of the stream. It continued to blow for quarter of an hour with the temperature at 66°, which was a drop of 22° in as many minutes, the barometer remaining steady at 29.52. The wind then eased off, and the barometer slowly rose, but fairly heavy rain continued until midnight. Through the rain was seen a glorious orange sunset low down on the horizon. By morning the sky was perfectly clear and the barometer had risen to 29.60, the ship being now with an ESE. breeze, force 4.—*W. E. H*

CLIMATOLOGICAL TABLES

DESCRIPTION OF TABLES AND CHARTS

Table 1 gives the data ordinarily needed for climatological studies for about 184 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m. daily, seventy-fifth meridian time, and for about 31 others making only one observation. The altitudes of the instruments above ground are also given.

Beginning January 1, 1928, movement and velocity of the wind are printed as recorded by the 3-cup anemometer which has replaced the 4-cup pattern.

Table 2 gives, for about 37 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sea-level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January, 1902, **30:** 13–16.

CHART I.—*Temperature departures.*—This chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly surface temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909, but smaller charts appear in W. B. Bulletin U for 1873 to June, 1909, inclusive.

CHART II.—*Tracks of centers* of ANTICYCLONES; and CHART III.—*Tracks of centers* of CYCLONES. The Roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., seventy-fifth meridian time. Within each circle is also given (Chart II), the last three figures of the highest barometric reading, or (Chart III) the lowest reading reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The inset map of Chart II shows the departure of monthly mean pressure from normal and the inset of Chart III shows the change in mean pressure from the preceding month.

The use of a new base map for Charts II and III is begun with this issue. Instead of showing the 12-hour movement of cyclones and anticyclones, only the 24-hour movement is shown.

CHART IV.—*Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

CHART V.—*Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this

chart shows the departure of the monthly totals from the corresponding normals.

CHART VI.—*Isobars at sea level, average surface temperatures, and prevailing wind directions.*—The pressures have been reduced to sea-level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January, 1902, 30:13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observation, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms can not be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at the great majority of the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

CHART VII.—*Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset of this chart, when included, shows the depth of snow on the ground at the end of the month.

CHARTS VIII, IX, etc.—*North Atlantic Weather maps of particular days.*

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, January, 1930

Section	Temperature		Monthly extremes						Precipitation		Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	46.0	+0.1	Citronelle	82	8	Riverton	1	[1] 18	4.45	−0.61	Robertsdale	7.78	Decatur	1.75
Arizona	41.6	−1.3	2 stations	79	4	Alpine	−18	21	2.09	+0.89	Pinal Ranch	6.79	Mohawk	0.07
Arkansas	33.8	−7.3	3 stations	74	[1] 1	Lead Hill	−28	22	9.16	+5.06	Arkadelphia	16.31	Ozark	3.21
California	41.9	−2.3	do	81	[1] 2	Twin Lakes	−19	11	5.30	−0.16	Cuyamaca	16.82	Greenland Ranch	0.04
Colorado	14.7	−9.5	5 stations	65	[1] 5	Pearl	−54	17	1.24	+0.44	Cumbres	8.59	Las Animas	0.00
Florida	62.2	+3.3	2 stations	89	[1] 2	Bluff Springs	16	19	3.52	+0.72	Niceville	8.62	Moore Haven	0.49
Georgia	48.2	+1.6	3 stations	81	[1] 2	Blue Ridge	8	19	5.00	+0.76	Montezuma	6.74	Resaca	3.18
Idaho	12.6	−9.8	Lapwai	66	4	Felt	−46	17	1.52	−0.61	2 stations	3.20	Richfield	0.30
Illinois	20.7	−6.1	Cairo	64	1	Mount Carroll	−35	22	4.69	+2.43	Grand Chain	10.50	Oregon	1.59
Indiana	25.4	−3.2	Rome	66	1	3 stations	−24	18	6.38	+3.33	Elliston	8.98	Whiting	1.72
Iowa	10.5	−8.0	Keokuk (No. 2)	58	5	Decorah	−37	22	1.33	+0.26	Keokuk	2.51	West Bend	0.41
Kansas	17.9	−11.9	Oakley	69	5	Valley Falls	−31	22	0.93	+0.30	Columbus	4.29	Norton	0.03
Kentucky	34.6	−0.8	Williamsburg	75	9	Murray	−20	18	4.85	+0.50	Mayfield	11.10	Pikeville	0.48
Louisiana	49.2	−2.0	2 stations	82	[1] 7	Plain Dealing	−3	18	7.83	+3.10	Logansport	11.66	Alexandria	5.18
Maryland-Delaware	34.1	+1.5	3 stations	75	9	Chewsville, Md	−17	19	2.75	−0.62	Mechanicsville, Md.	4.31	Picardy, Md	0.56
Michigan	17.7	−2.1	Muskegon	55	6	Dukes	−33	26	2.14	+0.32	Monroe	4.48	Bad Axe	0.62
Minnesota	1.4	−7.1	Worthington	50	4	Warroad	−49	9	0.61	−0.08	New Ulm	2.05	Redby	T.
Mississippi	45.4	−1.6	4 stations	80	[1] 9	2 stations	−2	18	5.37	+0.35	Austin	14.15	Pontotoc	2.37
Missouri	20.8	−9.7	Campbell	73	4	Neosho	−31	22	4.51	+2.47	Caruthersville	13.58	Tarkio	0.71
Montana	3.5	−15.0	St. Ignatius	55	4	Grant	−52	17	0.55	−0.41	Hebgen Dam	3.14	4 stations	T.
Nebraska	11.2	−10.3	4 stations	67	[1] 3	Gordon	−39	17	0.77	+0.22	Falls City	2.58	2 stations	0.20
Nevada	25.4	−5.1	Beatty	70	[1] 1	San Jacinto	−37	21	1.40	+0.31	Lewers Ranch	5.49	Thorne	0.16
New England	23.4	+1.1	Colchester, Conn	65	9	Van Buren, Me	−33	23	2.66	−0.73	Nantucket, Mass	4.42	Bethlehem, N. H	0.85
New Jersey	31.7	+1.9	Belleplain	72	9	Layton	−14	20	2.92	−0.67	Pleasantville	4.03	Culvers Lake	1.80
New Mexico	28.7	−5.3	Rodeo	75	1	Dulce	−41	22	0.63	+0.09	Aspen Grove Ranch	4.28	4 stations	0.00
New York	24.6	+2.0	2 stations	67	9	Stillwater Reservoir	−34	26	3.12	+0.21	High Market	6.82	Gabriels	1.15
North Carolina	43.3	+2.2	Kinston	82	10	Banners Elk	−3	24	3.85	−0.27	Willard	7.10	Parker	1.26
North Dakota	−1.9	−6.8	Powers Lake	41	1	Eckman	−43	9	0.29	−0.25	Bowman	1.41	3 stations	0.00
Ohio	27.8	−0.1	Portsmouth	72	9	Paulding	−18	23	4.69	+1.80	West Manchester	8.15	Canfield	1.17
Oklahoma	24.9	−13.4	4 stations	75	1	Watts	−27	18	2.40	+1.01	Watts	6.31	Boise City	0.20
Oregon	21.7	−10.9	2 stations	65	[1] 28	Danner	−52	21	3.18	−1.52	Willow Creek	10.28	Andrews	0.53
Pennsylvania	29.2	+1.4	Hanover	72	9	Lancaster	−24	19	2.25	−1.08	Emporium	4.74	Hyndman	0.70
South Carolina	46.9	+1.4	Garnett	80	2	Caesar's Head	10	17	4.46	+0.89	Ferguson	7.50	Charleston	2.37
South Dakota	6.0	−9.9	2 stations	61	[1] 4	2 stations	−36	17	0.53	−0.07	Menno	1.85	2 stations	T.
Tennessee	38.1	−0.6	Etowah	77	9	Halls	−12	18	4.99	+0.25	Union City	13.26	Clinton	1.61
Texas	39.1	−9.4	Riogrande	88	[1] 8	Miami	−15	10	1.81	−0.02	Lufkin	8.76	3 stations	0.00
Utah	18.8	−6.4	St. George	65	3	Woodruff	−44	21	1.73	+0.44	Silver Lake	7.00	Myton	0.32
Virginia	38.3	+2.5	Emory	79	1	Dale Enterprise	−13	20	2.67	−0.66	Wallaceton	4.67	Mount Weather	0.99
Washington	18.4	−12.1	3 stations	59	[1] 1	Toppenish	−32	21	2.46	−2.91	Big Four	10.74	Omak	0.06
West Virginia	34.0	+1.9	Moorefield	80	9	Ryan	−13	19	1.86	−1.96	Pickens	3.60	Upper Tract	0.58
Wisconsin	8.9	−5.0	Milwaukee County Airport.	50	7	Hatfield	−45	22	1.16	−0.07	Sheboygan	2.46	Park Falls	0.30
Wyoming	5.4	−13.7	Yoder	65	4	Riverside	−57	17	0.82	−0.04	Snake River	2.99	Deaver	0.11
Alaska [Dec.]	5.8	−0.4	Seward	65	21	Rampart	−59	31	1.70	−0.87	Yakutat	13.12	Shaktoolik	0.04
Hawaii	68.3	−0.2	Olaa Mill	89	29	Volcano Observatory	43	14	10.26	+0.97	Eke	31.20	Puu Kihe	1.63
Porto Rico	73.2	−0.1	Mayaguez	91	24	Guineo Reservoir	50	8	6.60	+3.02	Rio Grande	30.76	Mona Island	1.26

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1930*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
New England							27.3	+2.8										77	2.69	−0.7										6.9		
Eastport	76	67	85	30.10	30.18	+0.18	22.7	+2.3	52	8	30	−2	28	16	30	22	17	76	2.14	−1.8	14	7,920	sw.	36	ne.	18	5	9	17	7.4	14.8	4.9
Greenville, Me.	1,070	6	----	28.95	30.18	----	14.3	----	45	8	25	−19	27	4	38	----	----	----	2.59	----	13	5,563	se.	29	----	29	10	7	14	----	21.0	----
Portland, Me.	103	82	117	30.10	30.23	+.18	24.3	+1.9	50	2	32	0	26	17	31	22	17	76	2.80	−1.2	12	5,484	n.	21	ne.	9	11	4	16	6.2	11.7	8.0
Concord	289	70	79	29.81	30.22	+.17	23.1	+1.5	59	8	33	−10	27	14	35	----	----	----	1.46	−1.5	10	3,370	nw.	19	nw.	4	12	6	13	5.5	10.1	7.7
Burlington	403	11	48	29.74	30.21	+.16	20.2	+1.4	51	8	28	−9	26	12	32	----	----	----	2.56	+0.8	14	9,222	s.	39	s.	12	2	6	23	8.4	8.2	4.3
Northfield	876	12	60	----	30.21	+.16	18.6	+3.4	55	7	29	−13	27	8	34	----	----	86	2.26	−0.1	13	4,963	s.	24	s.	7	2	9	20	7.5	10.8	7.6
Boston	125	106	165	30.08	30.22	+.17	31.8	+3.9	64	8	39	8	17	24	26	28	22	70	2.77	−0.8	11	5,536	nw.	27	nw.	10	7	7	17	7.0	7.7	0.8
Nantucket	12	14	90	30.20	30.20	+.16	35.0	+3.7	57	9	41	14	26	29	25	32	30	85	4.42	+0.6	13	10,363	sw.	47	ne.	30	6	6	19	7.4	10.1	4.0
Block Island	26	11	46	30.18	30.20	+.13	33.7	+2.7	56	8	40	12	26	28	27	31	26	80	3.23	−0.6	10	11,959	w.	44	n.	30	8	8	15	6.3	6.3	1.5
Providence	160	215	251	30.04	30.23	+.17	30.8	+3.6	62	8	38	8	26	24	24	28	22	71	2.62	−1.1	9	7,164	nw.	37	nw.	10	7	8	16	6.5	6.6	2.5
Hartford	159	122	----	30.04	30.23	+.16	29.2	+3.7	59	7	36	7	26	22	23	----	----	----	2.51	−1.4	10	----	nw.	----	----	----	7	6	18	7.0	3.1	0.4
New Haven	106	74	153	30.12	30.25	+.17	30.8	+2.6	58	8	38	10	26	24	26	28	23	74	2.86	−1.1	10	5,612	n.	28	n.	10	6	10	15	6.8	5.6	0.8
Middle Atlantic States							34.8	+2.5										76	2.78	−0.5										6.9		
Albany	97	107	115	30.12	30.24	+.17	26.1	+3.0	57	8	34	−6	24	19	27	24	20	77	1.77	−0.6	10	5,087	s.	23	s.	7	13	5	13	5.8	8.3	3.0
Binghamton	871	10	84	29.24	30.20	+.12	26.1	+2.0	59	7	34	0	20	18	25	----	----	----	1.77	−0.7	14	4,337	nw.	24	sw.	7	2	9	20	8.0	7.7	1.0
New York	314	414	454	29.88	30.24	+.14	33.6	+2.7	65	9	41	10	19	27	29	31	25	70	2.58	−1.1	9	9,979	nw.	46	nw.	4	3	6	22	7.8	4.1	0.5
Bellefonte	1,050	5	36	29.06	30.21	----	25.8	----	61	7	35	−7	20	17	37	23	19	77	1.08	----	15	----	w.	----	----	----	5	6	20	7.9	5.0	1.8
Harrisburg	374	94	104	29.84	30.27	+.17	30.2	+1.2	60	8	37	5	20	23	35	27	21	69	1.69	−1.4	10	3,804	nw.	22	nw.	29	6	6	19	7.3	12.8	4.1
Philadelphia	114	123	367	30.13	30.26	+.15	35.6	+3.0	69	9	42	11	19	29	34	32	26	69	3.15	−0.2	9	8,382	nw.	37	nw.	10	8	2	21	7.0	3.9	0.8
Reading	325	81	98	29.89	30.26	----	31.2	+1.8	67	9	38	2	20	24	27	28	24	75	2.29	−1.3	8	3,660	w.	22	n.	10	8	2	21	7.2	12.2	1.2
Scranton	805	111	119	29.34	30.24	+.15	28.8	+2.2	59	7	36	−1	19	21	37	26	22	77	1.20	−1.8	13	4,453	sw.	22	n.	10	4	11	16	7.4	6.1	0.5
Atlantic City	52	37	172	30.19	30.25	+.14	36.4	+3.9	63	10	43	11	19	30	35	34	31	82	3.75	+0.3	13	11,069	nw.	48	ne.	30	8	8	15	6.3	7.0	4.8
Cape May	17	13	49	----	----	----	36.5	+2.4	61	2	43	15	19	30	35	33	31	84	3.50	+0.1	11	----	nw.	----	----	----	7	9	15	----	8.9	5.3
Sandy Hook	22	10	55	30.21	30.24	----	33.0	----	59	9	39	11	19	27	23	30	26	77	2.81	−1.2	11	9,607	nw.	40	nw.	18	7	5	19	7.1	2.4	0.8
Trenton	190	159	183	30.03	30.24	----	33.0	+2.5	67	9	40	8	19	26	29	30	25	75	2.73	−0.6	9	6,191	nw.	32	nw.	10	8	5	18	7.0	3.1	0.3
Baltimore	123	100	215	30.12	30.25	+.13	36.2	+2.4	69	8	43	11	19	29	37	32	28	74	2.66	−0.8	8	6,033	s.	36	nw.	10	9	4	18	6.7	14.1	9.0
Washington	112	62	85	30.13	30.26	+.13	35.6	+2.2	70	9	43	6	31	28	33	32	26	71	2.85	−0.7	11	3,691	s.	26	n.	10	10	5	16	6.7	14.0	9.5
Cape Henry	18	8	54	30.21	30.23	----	43.6	+3.4	74	14	51	24	19	36	31	40	37	84	4.48	+1.3	14	9,073	n.	44	n.	10	6	9	16	6.8	3.9	1.5
Lynchburg	681	153	188	29.50	30.27	+.14	39.2	+1.7	74	9	48	7	31	30	35	34	29	70	2.77	−0.7	14	4,269	w.	24	nw.	18	6	12	13	6.1	12.0	6.0
Norfolk	91	170	205	30.15	30.26	+.13	44.0	+3.4	74	9	52	21	31	36	34	40	37	82	4.09	+1.0	14	8,295	n.	35	n.	30	6	8	17	6.8	4.1	2.6
Richmond	144	11	52	30.10	30.27	+.13	39.6	+1.7	75	10	48	11	31	31	40	35	32	79	4.25	+1.0	14	4,853	ne.	27	sw.	2	8	10	13	6.2	9.6	5.0
Wytheville	2,304	49	55	27.78	30.25	+.11	35.6	+2.6	71	9	45	8	19	26	32	31	27	77	1.65	−1.4	13	4,042	w.	24	nw.	3	8	8	15	6.5	15.0	5.8
South Atlantic States							48.2	+2.7										79	3.49	−0.1										6.2		
Asheville	2,253	70	84	27.81	30.25	+.10	39.8	+4.4	71	9	49	11	19	31	32	34	30	74	1.48	−1.6	9	6,436	se.	27	n.	23	9	10	12	6.1	8.7	4.0
Charlotte	779	55	62	29.38	30.24	+.09	44.0	+2.8	73	10	53	22	30	35	29	39	35	77	3.90	−0.1	14	3,442	ne.	20	ne.	29	7	10	14	6.6	6.0	2.2
Greensboro	886	5	56	29.27	30.25	----	39.7	----	72	10	50	5	31	29	40	35	32	81	3.03	----	13	5,195	sw.	30	ne.	29	3	12	16	6.9	8.0	4.0
Hatteras	11	5	50	30.20	30.21	+.07	50.6	+3.5	74	14	58	31	31	44	27	47	45	86	5.02	+0.6	17	9,661	n.	50	n.	30	8	8	15	6.5	T.	0.0
Raleigh	376	103	110	29.83	30.25	+.12	43.9	+2.8	75	10	53	19	19	35	35	39	35	76	2.95	−0.7	14	4,647	ne.	24	nw.	15	9	7	15	6.2	3.0	2.0
Wilmington	78	81	91	30.15	30.24	+.10	48.8	+2.3	75	10	58	25	31	40	29	44	43	87	3.69	+0.4	14	4,072	n.	19	ne.	29	10	6	15	6.1	0.4	0.0
Charleston	48	11	92	30.17	30.22	+.07	51.2	+1.3	73	10	59	29	30	44	23	47	44	83	2.37	−0.6	13	6,560	n.	42	e.	29	11	4	16	6.0	T.	0.0
Columbia, S. C.	351	41	57	29.85	30.24	+.09	48.0	+2.0	76	9	57	24	30	39	31	42	38	77	3.35	−0.1	14	4,203	ne.	25	ne.	29	6	11	14	6.2	0.6	0.0
Due West	711	10	55	29.46	30.26	----	44.8	----	75	10	54	23	30	35	28	----	----	----	3.05	----	13	5,426	ne.	30	ne.	29	7	11	13	6.0	1.6	T.
Greenville, S. C.	1,039	139	146	29.10	30.22	----	44.6	+4.3	76	10	53	22	19	36	27	39	35	74	4.18	−0.7	13	5,094	ne.	29	ne.	29	9	7	15	6.1	9.0	0.2
Augusta	182	62	77	30.02	30.22	+.06	49.6	+2.6	76	9	59	26	24	40	33	43	39	75	5.31	+1.4	14	3,247	nw.	20	ne.	29	6	13	12	5.8	0.1	0.0
Savannah	65	150	194	30.14	30.20	+.05	53.0	+1.6	77	2	62	30	30	45	27	47	44	79	3.59	+0.8	10	7,443	ne.	30	s.	15	10	6	15	5.9	T.	0.0
Jacksonville	43	209	245	30.14	30.19	+.04	57.0	+1.6	78	28	65	32	24	49	27	51	47	80	2.55	−0.2	9	7,133	n.	37	nw.	29	7	10	14	6.5	0.0	0.0
Florida Peninsula							69.3	+3.8										83	2.96	+0.6										5.0		
Key West	22	10	64	30.08	30.10	.00	71.9	+2.4	83	29	77	56	31	67	16	68	66	88	4.28	+2.3	9	6,808	ne.	31	sw.	18	16	10	5	3.6	0.0	0.0
Miami	25	141	168	30.10	30.13	−.01	71.4	+4.9	81	15	77	45	31	66	21	66	64	81	2.72	+0.2	13	7,623	s.	31	ne.	5	10	14	7	5.3	0.0	0.0
Tampa	35	79	197	30.12	30.16	+.04	64.5	+4.1	82	2	74	42	26	55	29	57	54	80	1.88	−0.8	8	8,100	n.	31	w.	18	8	9	14	6.4	0.0	0.0
Titusville	44	5	----	30.10	30.15	----	64.6	----	85	22	74	36	31	55	34	----	----	----	2.25	----	8	----	nw.	----	----	----	----	----	----	4.7	0.0	0.0
East Gulf States							47.6	−0.5										76	4.96	+0.2										5.7		
Atlanta	1,173	190	216	28.96	30.23	+.08	42.8	+0.2	71	9	51	15	19	35	24	39	35	76	5.35	+0.4	12	8,061	nw.	32	nw.	3	10	8	13	5.6	3.0	T.
Macon	370	78	87	29.83	30.24	+.08	47.4	+0.6	74	2	58	22	24	37	34	42	37	74	4.27	+0.1	9	4,220	nw.	27	ne.	29	9	8	14	5.8	T.	0.0
Thomasville	273	49	58	29.90	30.21	+.05	53.2	+2.2	77	8	63	26	19	44	29	48	44	80	5.70	+1.6	13	5,852	ne.	15	w.	3	8	11	12	6.1	0.0	0.0
Apalachicola	36	11	51	30.15	30.19	----	53.6	----	73	15	61	29	19	46	24	50	46	82	6.36	+2.7	9	3,130	n.	22	n.	3	14	4	13	5.3	0.0	0.0
Pensacola	56	149	185	30.14	30.21	+.07	51.0	−1.5	69	2	59	20	19	44	30	48	44	80	4.64	+0.6	9	8,649	n.	36	ne.	29	11	9	11	5.5	0.0	0.0
Anniston	741	9	57	29.43	30.26	+.10	43.4	+1.2	75	9	53	12	19	34	37	----	----	----	4.16	−1.0	10	4,000	nw.	20	nw.	3	14	4	13	6.1	9.5	1.0
Birmingham	700	11	48	29.46	30.25	+.09	44.2	−0.9	74	9	53	11	19	35	29	39	34	73	4.25	−1.3	10	5,645	n.	23	se.	7	11	6	14	5.9	7.4	T.
Mobile	57	125	161	30.15	30.21	+.06	50.5	−1.0	72	10	59	18	19	42	28	46	41	77	4.74	−0.1	8	7,687	n.	39	n.	29	7	11	13	6.1	0.0	0.0
Montgomery	223	100	112	29.99	30.25	+.09	48.5	+0.3	76	9	58	18	19	39	29	43	37	70	4.92	−0.3	10	4,929	n.	22	n.	3	12	7	12	5.2	T.	0.0
Corinth	469	6	----	----	----	----	40.3	----	72	9	50	0	18	31	31	----	----	----	6.46	----	12	----	se.	----	----	----	4	17	10	----	2.0	0.0
Meridian	375	87	95	29.82	30.23	+.07	45.2	−1.8	76	9	54	11	19	36	32	41	36	75	4.56	−0.8	9	4,333	s.	18	n.	3	11	4	16	5.8	4.5	T.
Vicksburg	247	65	73	29.96	30.25	+.10	45.2	−3.0	75	8	54	11	19	37	32	40	34	71	3.79	−1.6	13	5,254	n.	20	nw.	18	10	7	14	6.0	1.0	0.0
New Orleans	53	76	84	30.15	30.21	+.08	52.6	−1.6	77	14	60	22	19	45	23	49	45	81	6.89	+2.6	9	4,936	n.	30	ne.	29	10	7	14	5.9	0.0	0.0
West Gulf States							40.1	−8.2										78	3.58	+0.8										6.8		
Shreveport	249	77	93	29.97	30.25	+.11	41.4	−5.6	70	1	50	−2	18	33	26	37	33	76	9.13	+5.2	13	4,272	nw.	18	nw.	21	12	3	16	6.2	2.4	0.0
Bentonville	1,303	11	44	28.80	30.23	+.09	25.2	−8.9	60	1	35	−17	18	16	35	----	----	----	4.91	----	13	4,398	n.	25	s.	6	13	1	17	----	10.3	T.
Fort Smith	457	79	94	29.75	30.25	+.11	29.1	−10.4	67	1	38	−9	18	21	33	27	23	80	3.96	+1.4	14	5,234	e.	22	w.	14	11	2	18	6.5	6.5	T.
Little Rock	357	136	153	29.86	30.26	+.11	35.0	−6.4	64	1	42	−4	18	28	26	31	26	72	12.47	+7.7	14	5,882	n.	26	n.	17	9	5	17	6.3	3.0	0.0
Austin	605	136	148	29.56	30.21	----	39.4	−10.1	72	7	48	4	18	30	35	36	33	80	2.02	0.0	13	5,938	n.	29	n.	21	8	2	21	6.9	0.3	0.0
Brownsville	57	83	100	30.09	30.15	----	53.8	−6.0	78	1	62	24	18	46	27	50	48	82	0.56	−0.9	10	7,791	nw.	33	s.	8	1	8	22	8.5	0.0	0.0
Corpus Christi	20	11	78	30.16	30.18	+.08	48.6	−7.4	76	8	56	14	18	42	31	46	43	84	0.75	−0.8	12	7,766	n.	31	n.	17	3	3	25	8.2	T.	0.0
Dallas	512	220	227	29.67	30.24	----	33.6	----	67	1	42	−3	18	25	32	----	----	----	1.30	−1.1	13	7,501	nw.	34	w.	1	14	1	16	5.8	0.5	0.0
Fort Worth	670	106	114	29.50	30.24	+.12	35.2	−10.2	70	1	44	−1	18	26	32	31	26	71	0.84	−1.2	9	5,475	nw.	25	s.	6	8	6	17	6.7	T.	0.0
Galveston	54	106	114	30.14	30.20	+.07	48.6	−5.2	69	1	55	13	18	42	27	46	44	86	5.07	+1.7	15	8,519	n.	32	nw.	28	8	4	19	6.7	T.	0.0
Groesbeck	461	11	56	29.72	30.23	----	36.9	----	69	6	46	−2	18	28	34	----	----	----	1.53	−1.2	13	7,024	n.	30	n.	17	10	3	18	6.4	2.0	0.0
Houston	138	292	314	30.05	30.20	----	46.2	−6.5	73	13	54	5	18	38	26	----	----	----	3.52	−0.2	15	9,093	nw.	37	n.	28	7	4	20	7.2	0.0	0.0
Palestine	510	64	72	29.69	30.24	+.12	37.7	−10.5	69	6	47	−4	18	28	33	35	30	79	3.19	−0.2	15	4,979	n.	21	n.	28	10	4	17	6.4	3.8	0.0
Port Arthur	34	58	66	30.15	30.19	----	48.4	----	72	14	56	11	18	41	33	----	----	----	6.76	+3.1	15	6,178	n.	30	n.	21	9	1	21	6.9	T.	0.0
San Antonio	693	119	132	29.45	30.20	+.10	43.2	−9.1	73	6	52	11	18	34	29	39	35	74	1.25	−0.2	12	4,503	ne.	26	n.	21	8	6	17	7.0	T.	0.0
Taylor	583	55	63	29.61	30.25	+.14	37.5	−10.0	71	7	46	0	18	20	36	----	----	----	1.36	−0.6	14	5,730	nw.	27	nw.	21	8	7	16	6.6	0.8	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1930*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Total	Departure from normal	Days with 0.01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
							33.0	-0.6										77	4.76	+1.0										6.9		
Chattanooga	762	190	215	29.42	30.26	+0.10	41.8	+0.6	70	9	50	10	23	33	25	36	28	64	2.30	-3.0	10	5,983	se.	29	nw.	3	10	7	14	5.9	4.7	0.0
Knoxville	995	102	111	29.16	30.25	+.10	40.3	+1.5	74	9	50	7	19	31	33	35	31	74	2.19	-2.5	13	4,155	sw.	30	s.	2	7	11	13	6.3	5.3	T.
Memphis	399	76	97	29.81	30.25	+.09	36.2	-4.7	69	1	43	-2	18	29	27	33	29	78	12.12	+7.3	14	5,301	n.	21	n.	17	9	6	16	6.4	4.0	0.0
Nashville	546	168	191	29.67	30.28	+.12	36.6	-2.0	69	9	45	-2	18	29	32	34	29	75	3.82	-0.9	13	7,140	s.	35	s.	8	10	4	17	6.2	1.4	0.0
Lexington	989	193	230	29.16	30.27	+.14	32.6	-0.3	70	9	40	-6	18	25	33	-----	-----	-----	4.44	+0.3	14	9,428	sw.	33	s.	7	7	8	16	6.5	2.6	0.0
Louisville	525	188	234	29.66	30.27	+.13	32.5	-1.9	66	9	40	-8	18	25	31	30	26	78	5.95	+2.0	16	7,603	s.	33	s.	1	9	6	16	6.0	3.7	0.0
Evansville	431	76	116	29.79	30.28	+.14	29.8	-3.7	62	1	37	-10	18	23	26	27	23	75	6.20	+2.5	16	6,210	s.	31	sw.	1	9	5	17	6.4	7.0	T.
Indianapolis	822	194	230	29.30	30.23	+.11	24.8	-3.6	59	1	32	-15	18	17	23	23	19	79	7.34	+4.4	16	7,402	sw.	29	sw.	6	6	6	19	7.2	6.9	2.2
Royal Center	736	11	55	29.38	30.22	-----	20.2	-----	52	6	28	-19	18	12	28	-----	-----	-----	3.87	+1.6	16	6,987	w.	28	w.	3	7	7	17	7.0	4.3	1.7
Terre Haute	575	96	129	29.59	30.24	-----	24.0	-----	59	1	32	-15	18	16	26	22	20	85	8.23	+5.5	15	6,474	s.	30	s.	6	8	6	17	6.5	12.3	3.1
Cincinnati	627	11	51	29.53	30.24	+.12	30.8	+0.5	62	1	39	-10	18	23	25	28	25	82	4.25	+0.8	16	5,671	s.	22	sw.	24	9	4	18	6.7	5.2	T.
Columbus	822	179	222	29.31	30.22	+.11	29.2	+0.6	61	14	37	-8	18	22	30	27	24	81	4.86	+1.8	19	7,243	s.	37	nw.	3	6	5	20	7.5	4.9	T.
Dayton	899	137	173	29.23	30.23	-----	28.4	-1.1	60	14	36	-11	18	21	25	26	23	81	5.27	+2.0	18	6,903	sw.	29	sw.	1	5	7	19	7.3	4.9	0.5
Elkins	1,947	59	67	28.11	30.26	+.14	33.2	+2.8	70	1	44	-7	19	23	43	29	25	76	1.55	-2.2	15	3,845	w.	26	w.	3	3	8	20	8.0	6.2	T.
Parkersburg	637	77	82	29.58	30.26	+.14	34.4	+1.9	69	9	43	0	19	26	33	30	26	75	2.16	-1.4	18	4,196	se.	22	w.	3	4	5	22	8.2	7.4	0.1
Pittsburgh	842	353	410	29.28	30.22	+.11	31.8	+1.1	63	7	40	0	19	24	35	29	24	74	1.67	-1.4	17	7,427	s.	29	nw.	4	4	6	21	7.7	6.9	0.5
Lower Lake Region							24.4	0.0										81	4.09	+1.5										7.8		
Buffalo	767	247	280	29.30	30.17	+.10	24.6	0.0	56	14	32	1	26	18	27	22	20	83	6.23	+2.9	25	12,869	w.	54	w.	15	3	9	19	7.8	20.0	4.2
Canton	448	10	61	29.67	30.18		19.6	+3.3	51	8	29	-23	26	10	38	-----	-----	-----	3.98	+1.5	20	7,459	sw.	31	sw.	15	2	12	17	7.5	14.4	6.2
Ithaca	836	5	100	29.26	30.20		24.0	-0.3	57	7	32	-6	23	16	25	22	18	78	1.66	-0.5	14	7,591	nw.	30	se.	1	2	5	24	8.5	7.2	0.6
Oswego	335	76	91	29.81	30.19	+.12	25.2	+1.3	55	8	32	-4	26	18	27	23	19	78	3.15	+0.2	17	8,276	s.	30	nw.	25	0	6	25	8.8	14.7	5.5
Rochester	523	86	102	29.60	30.19	+.13	26.2	+1.6	57	7	33	2	26	19	27	23	19	75	2.92	0.0	21	6,415	sw.	30	w.	25	1	9	21	8.4	6.2	1.5
Syracuse	596	65	79	29.54	30.21	+.14	26.3	+3.3	58	7	34	1	26	19	29	-----	-----	-----	2.74	-0.3	19	5,062	s.	21	sw.	25	1	9	21	8.1	6.0	2.5
Erie	714	130	166	29.39	30.19	+.11	26.2	-0.6	59	1	34	-1	18	19	27	24	20	78	3.89	+1.1	15	9,824	s.	37	sw.	24	3	8	20	7.8	8.2	3.9
Cleveland	762	267	337	29.34	30.19	+.10	27.6	+1.1	62	14	36	-3	18	20	30	24	21	79	5.01	+2.5	15	9,436	s.	50	nw.	3	3	7	21	7.7	5.5	1.8
Sandusky	629	5	67	29.49	30.21	+.12	25.4	-0.9	58	14	33	-9	18	18	26	-----	-----	-----	5.41	+3.2	18	6,392	sw.	29	nw.	3	4	7	20	7.3	5.3	1.7
Toledo	628	208	243	29.50	30.21	+.12	23.7	-2.1	53	7	31	-10	18	17	24	22	18	81	4.67	+2.5	19	9,274	sw.	37	w.	15	10	6	15	6.3	7.3	3.0
Fort Wayne	856	113	124	29.24	30.20		22.2	-4.7	53	6	29	-15	18	15	25	21	18	86	5.62	+3.3	19	6,601	sw.	26	w.	3	5	6	20	7.7	7.8	4.4
Detroit	730	218	258	29.36	30.19	+.11	22.8	-1.6	50	7	29	-7	18	16	24	22	19	88	3.85	+1.8	21	7,235	sw.	34	sw.	25	2	13	16	7.6	16.5	3.1
Upper Lake Region							15.4	-3.4										83	1.96	+0.1										6.9		
Alpena	609	13	92	29.45	30.15	+.11	17.8	-1.3	44	7	24	-8	26	11	23	16	13	82	1.36	-0.5	13	7,749	sw.	30	se.	11	3	10	18	7.3	10.3	8.6
Escanaba	612	54	60	29.45	30.15	+.10	11.7	-3.7	39	1	19	-18	18	4	26	10	8	85	0.94	-0.6	7	6,384	nw.	25	ne.	14	14	5	12	5.3	10.8	16.0
Grand Haven	632	54	89	29.44	30.17	+.10	21.2	-3.1	47	1	26	0	10	16	19	21	19	90	3.18	+0.8	19	8,706	w.	39	w.	14	2	3	26	8.9	28.4	9.0
Grand Rapids	707	70	87	29.38	30.18	+.12	21.4	-3.1	50	6	27	-4	18	16	25	20	17	82	3.21	+0.9	17	4,397	sw.	20	nw.	25	1	8	22	8.1	37.3	8.0
Houghton	668	64	99	29.36	30.13	+.08	10.2	-4.5	37	5	16	-23	18	4	28	-----	-----	-----	2.65	+0.2	21	6,692	w.	29	w.	19	0	6	25	8.9	26.9	22.0
Lansing	878	6	49	29.19	30.17		18.2	-4.2	46	7	26	-13	18	11	25	18	17	96	2.53	+0.7	22	3,725	sw.	19	w.	28	7	7	17	7.0	23.8	8.0
Ludington	637	60	66	29.42	30.15		20.2	-2.9	42	1	25	0	18	15	16	19	16	82	2.04	-0.1	21	8,120	w.	40	sw.	14	3	10	18	7.7	22.0	5.8
Marquette	734	77	111	29.29	30.14	+.10	13.3	-3.0	41	5	20	-15	18	7	28	11	8	82	2.23	-0.1	18	7,061	w.	28	w.	15	4	7	20	7.5	22.0	26.5
Port Huron	638	70	120	29.45	30.17	+.11	20.3	-2.0	46	7	27	-7	26	13	23	19	17	86	2.41	+0.6	20	7,972	sw.	26	w.	28	3	15	13	6.6	16.7	7.0
Sault Ste. Marie	614	11	52	29.40	30.14	+.11	11.6	-1.7	40	6	19	-16	26	4	30	10	7	86	1.12	-0.8	10	5,355	sw.	30	nw.	25	6	9	16	6.7	11.8	17.0
Chicago	673	7	131	29.45	30.21	+.11	20.1	-3.6	51	6	27	-16	18	14	25	18	14	77	2.23	+0.3	16	7,770	sw.	34	sw.	14	8	7	16	6.3	14.1	3.0
Green Bay	617	109	141	29.46	30.16	+.10	11.0	-4.7	41	5	18	-24	18	4	30	10	5	75	0.90	-0.6	9	7,346	sw.	31	n.	14	8	7	16	6.1	10.6	6.4
Milwaukee	681	125	221	29.40	30.18	+.10	16.4	-4.2	48	6	24	-21	18	9	26	15	11	77	2.13	+0.4	17	9,671	w.	36	sw.	14	13	4	14	5.7	21.7	6.8
Duluth	1,133	5	47	28.88	30.18	+.09	2.0	-5.9	34	5	11	-38	17	-7	32	1	-2	79	0.54	-0.4	7	9,094	nw.	36	nw.	2	14	8	9	4.5	5.4	9.4
North Dakota							-1.9	-6.8										86	0.21	-0.3										6.0		
Moorhead	940	50	58	29.17	30.26	+.12	0.3	-3.5	33	1	9	-30	9	-8	35	-1	-3	80	0.46	-0.2	11	5,836	n.	24	n.	24	4	12	15	6.6	6.0	4.8
Bismarck	1,674	8	57	28.35	30.28	+.15	-0.4	-8.2	31	3	8	-28	9	-8	33	-1	-4	84	0.23	-0.2	6	5,665	nw.	25	nw.	27	10	12	9	5.1	2.7	4.5
Devils Lake	1,478	11	44	28.55	30.25	+.13	-5.2	-7.0	26	1	4	-35	9	-14	30	-7	-8	89	0.06	-0.4	4	6,104	w.	26	n.	24	10	6	15	6.1	0.7	8.1
Ellendale	1,457	10	56	28.60	30.27	-----	0.8	-----	32	1	10	-30	9	-8	37	-----	-----	-----	0.14	-0.3	6	9,056	nw.	31	n.	6	5	11	15	6.7	4.1	2.3
Grand Forks	833	12	67	-----	-----	-----	-2.5	-----	31	1	7	-33	9	-12	32	-4	-----	-----	0.27	-----	8	-----	nw.	29	nw.	6	16	12	3	-----	4.1	6.6
Williston	1,878	41	48	28.16	30.29	+.18	-2.2	-8.6	38	3	6	-28	16	-10	35	-3	-7	80	0.17	-0.4	3	5,046	w.	25	w.	17	11	9	11	5.3	1.9	7.6
Upper Mississippi Valley							14.8	-6.7										82	2.72	+1.2										5.7		
Minneapolis	918	102	208	29.16	30.20	-----	7.0	-5.7	40	5	15	-20	17	-1	44	-----	-----	-----	0.95	+0.1	8	7,313	w.	20	n.	14	9	8	14	5.8	11.0	6.5
St. Paul	837	236	261	29.25	30.22	+.11	6.4	-6.2	40	5	15	-25	17	-2	42	-----	-----	-----	1.00	+0.1	11	7,309	sw.	29	nw.	14	9	11	11	5.6	13.8	9.0
La Crosse	714	11	48	29.39	30.22	+.11	9.0	-7.1	46	5	19	-27	22	-1	44	7	4	85	1.63	+0.6	13	3,312	s.	14	nw.	3	11	8	12	5.7	19.5	7.6
Madison	974	70	78	29.09	30.21	+.11	11.4	-5.3	45	5	19	-24	18	3	30	10	7	82	1.86	+0.5	12	5,401	w.	27	n.	9	14	4	13	5.3	17.6	8.3
Wausau	1,247	4	64	28.75	30.16	-----	8.4	-----	42	5	16	-26	18	1	20	-----	-----	-----	0.77	-0.5	7	4,214	w.	18	w.	6	5	8	18	7.2	14.3	9.8
Charles City	1,015	10	51	29.10	30.25	+.11	6.6	-7.1	48	5	17	-31	22	-4	41	5	3	87	1.41	+0.4	9	4,273	nw.	18	sw.	12	13	9	9	4.8	16.5	10.2
Davenport	606	71	79	29.54	30.24	+.12	14.8	-7.0	52	5	24	-18	18	6	41	13	10	84	2.05	+0.6	16	7,199	w.	35	sw.	14	13	5	13	5.3	17.7	6.0
Des Moines	861	84	97	29.30	30.27	+.13	12.4	-7.7	54	4	22	-20	22	3	38	11	7	82	1.41	+0.3	12	6,878	nw.	25	nw.	6	13	8	10	4.7	16.5	10.0
Dubuque	700	81	96	29.43	30.23	+.11	11.8	-7.3	48	5	21	-24	22	3	40	10	7	81	2.05	+0.8	15	4,226	nw.	16	n.	9	10	6	15	6.1	21.1	7.9
Keokuk	614	64	78	29.56	30.28	+.14	16.9	-8.0	56	6	26	-17	18	8	42	14	11	80	2.51	+1.0	13	5,530	sw.	26	sw.	14	12	3	16	5.8	16.4	9.0
Cairo	358	87	93	29.86	30.27	+.11	30.6	-4.3	64	1	38	-8	18	23	31	28	23	75	9.44	+5.7	14	6,605	n.	34	nw.	14	9	3	19	6.6	5.5	0.0
Peoria	609	11	45	29.55	30.26	+.14	17.0	-6.1	52	6	26	-19	18	8	32	16	14	88	2.81	+1.0	14	4,805	s.	24	w.	14	15	3	13	5.0	14.1	5.8
Springfield, Ill	636	154	191	29.53	30.24	+.11	19.6	-6.9	56	1	28	-18	18	12	26	18	16	86	3.80	+1.7	14	8,509	nw.	32	s.	6	10	6	15	6.0	6.1	3.7
Hannibal	534	74	109	29.66	30.26	+.13	18.6	-8.5	57	6	27	-17	18	10	39	-----	-----	-----	3.45	+1.7	16	6,216	sw.	27	sw.	14	13	2	16	5.6	11.6	5.0
St. Louis	568	205	303	29.62	30.26	+.12	24.7	-6.1	60	1	32	-13	18	17	28	22	18	76	5.70	+3.4	12	7,641	nw.	44	sw.	6	13	3	15	5.5	11.0	0.4
Missouri Valley							13.9	-8.9										79	1.72	+0.7										5.4		
Columbia, Mo	784	6	84	29.38	30.26	+.13	20.4	-8.8	57	6	29	-16	18	12	35	-----	-----	-----	4.41	+2.5	12	5,598	sw.	22	s.	6	12	3	16	6.0	8.5	5.6
Kansas City	963	161	181	29.19	30.28	+.13	18.6	-9.6	54	5	27	-12	17	10	38	16	12	80	2.56	+1.4	13	7,694	n.	30	nw.	2	10	11	10	5.2	22.2	4.8
St. Joseph	967	11	49	29.17	30.27	-----	15.4	-----	53	5	24	-17	22	7	39	13	10	82	1.30	+0.2	11	5,839	nw.	26	nw.	2	12	10	9	4.8	13.9	5.8
Springfield, Mo	1,324	98	104	28.79	30.26	+.12	23.8	-9.7	60	1	32	-17	18	15	32	21	18	83	5.27	+2.9	12	6,693	s.	27	w.	1	10	6	15	6.0	9.2	0.3
Iola	984	11	50	29.16	30.28	+.14	18.0	-11.8	54	5	28	-18	18	8	35	-----	-----	-----	2.34	+1.0	8	4,823	n.	20	s.	5	8	8	15	6.4	10.5	1.0
Topeka	987	92	107	-----	-----	-----	16.8	-10.8	56	4	25	-13	22	9	39	-----	-----	-----	0.91	0.0	10	6,675	n.	28	sw.	6	11	11	9	5.1	11.0	4.8
Lincoln	1,189	11	81	28.94	30.29	+.14	14.0	-8.8	56	4	22	-16	17	6	43	12	7	76	0.87	+0.2	9	6,746	n.	29	nw.	14	13	6	12	5.2	3.7	0.4
Omaha	1,105	115	122	29.02	30.28	+.13	14.0	-7.9	55	4	22	-16	17	7	43	12	7	77	1.73	+1.0	10	6,289	nw.	31	n.	6	13	9	9	4.5	17.3	3.3
Valentine	2,598	47	54	27.40	30.30	+.18	8.3	-10.6	65	5	20	-30	17	-3	57	6	3	81	0.77	+0.3	10	4,526	w.	24	nw.	24	10	12	9	5.3	13.4	0.2
Sioux City	1,135	94	164	28.99	30.29	+.14	10.4	-7.4	48	4	18	-22	17	2	39	9	4	75	0.64	-0.1	8	7,891	nw.	37	nw.	14	12	10	9	5.3	8.1	2.7
Huron	1,306	59	74	28.80	30.30	+.14	5.4	-5.9	47	4	15	-29	17	-4	37	4	0	80	0.40	-0.2	9	6,126	nw.	23	w.	24	7	13	11	5.7	6.5	4.0
Pierre	1,572	70	75	28.52	30.31	+.18	8.0	-8.0	41	1	16	-24	17	-1	38	6	1	73	0.28	-0.2	8	5,355	nw.	29	nw.	6	9	13	9	5.1	4.1	0.4
Yankton	1,233	49	57	28.89	30.30	+.14	9.3	-8.0	52	4	18	-24	17	0	34	-----	-----	-----	0.88	+0.3	8	5,245	nw.	25	nw.	6	9	12	10	5.4	10.2	3.2

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	°F.		°F.	°F.		°F.	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
Northern Slope							6.4	−13.2										78	0.60	−0.1										5.6		
Billings	3,140	5					7.9		51	3	19	−39	17	−3	39				0.54		8		nw.				16	8	7		6.2	
Havre	2,505	11	44	27.51	30.34	+0.24	2.6	−10.3	44	3	12	−31	16	−6	38	2	0	90	0.18	−0.6	8	5,209	sw.	30	sw.	17	6	11	14	6.4	3.6	1.0
Helena	4,110	87	112	25.86	30.33	+.18	4.0	−16.2	48	4	13	−32	17	−5	54	2	−4	71	0.77	−0.1	16	3,589	sw.	23	sw.	31	7	8	16	6.6	13.3	9.4
Kalispell	2,973	48	56	27.04	30.31	+.19	5.4	−15.0	46	4	14	−23	17	−3	34	4	1	82	0.80	−0.8	9	3,156	nw.	28	ne.	5	13	7	11	5.0	8.4	9.0
Miles City	2,371	48	55	27.62	30.35	+.23	3.6	−10.9	43	3	12	−31	16	−5	47	2	0	86	0.35	−0.3	10	3,391	nw.	20	nw.	23	8	14	9	5.6	4.9	3.4
Rapid City	3,259	50	58	26.67	30.33	+.23	8.7	−13.3	57	4	20	−33	17	−2	56	6	0	71	0.64	+0.2	12	4,365	nw.	31	ne.	5	8	9	14	6.0	7.8	3.4
Cheyenne	6,088	84	101	23.89	30.18	+.13	13.0	−12.5	54	5	23	−30	17	3	47	10	3	67	0.88	+0.5	14	7,961	w.	50	w.	1	10	7	14	6.1	13.0	2.2
Lander	5,372	60	68	24.58	30.29	+.17	3.0	−15.3	49	5	15	−39	17	−9	37	0	−3	82	0.54	0.0	5	2,219	e.	37	sw.	5	15	8	8	4.5	5.2	3.4
Sheridan	3,790	10	47	26.13	30.28		5.6		54	3	18	−36	17	−6	56	4	−2	72	0.69	−0.2	12	2,606	nw.	22	nw.	1	8	13	10	5.6	7.0	6.0
Yellowstone Park	6,241	11	48																													
North Platte	2,821	11	51	27.17	30.29	+.17	10.6	−12.3	60	4	22	−26	17	−1	47	7	3	78	0.51	+0.1	9	4,247	w.	20	n.	6	14	5	12	4.9	5.7	1.6
Middle Slope							19.0	−11.5										74	1.35	+0.5										5.1		
Denver	5,292	106	113	24.66	30.17	+.12	16.9	−12.9	57	5	28	−20	17	6	38	13	7	68	0.48	+0.1	11	4,369	n.	19	w.	27	16	11	4	3.9	12.5	0.0
Pueblo	4,685	80	86	25.24	30.14	+.09	18.8	−11.1	62	4	32	−17	18	6	46	14	7	65	0.51	+0.2	8	3,773	nw.	32	w.	5	18	11	2	3.5	5.9	0.0
Concordia	1,392	50	58	28.74	30.31	+.17	16.4	−10.0	58	4	25	−13	17	8	39	13	7	72	0.68	+0.1	9	5,682	n.	25	sw.	4	11	9	11	5.3	8.9	0.5
Dodge City	2,509	11	51	27.53	30.28	+.17	19.6	−9.4	58	4	31	−12	17	8	37	15	11	76	0.32	−0.1	7	6,245	nw.	28	sw.	4	15	9	7	4.2	2.9	0.0
Wichita	1,358	139	158	28.75	30.26	+.13	19.0	−12.3	56	5	27	−12	18	11	35	17	13	79	1.24	+0.5	8	7,942	n.	40	s.	4	10	10	11	5.6	10.6	1.0
Broken Arrow	765	11	56	29.40	30.26		23.5		65	1	32	−12	18	15	33				3.53	+1.5	12	8,451	n.	33	s.	6	8	6	17	6.7	9.3	1.8
Oklahoma City	1,214	10	47	28.92	30.27	+.16	23.2	−13.2	63	1	32	−9	17	14	36	20	17	81	2.69	+1.5	9	6,750	n.	25	nw.	9	10	5	16	6.7	8.4	4.0
Southern Slope							34.0	−8.8										68	0.37	−0.3										5.7		
Abilene	1,738	10	52	28.35	30.23	+.14	33.0	−11.2	70	6	44	−2	18	22	37	28	22	72	0.56	−0.4	8	6,146	n.	31	s.	26	9	8	14	6.4	0.8	0.0
Amarillo	3,676	10	49	26.31	30.18	+.12	25.8	−9.5	65	5	36	−8	17	15	35	21	14	65	0.57	+0.1	6	5,960	sw.	23	sw.	31	13	6	12	5.1	9.4	0.0
Del Rio	944	64	71	29.15	30.17	+.11	43.8	−8.5	77	27	54	13	23	34	32	39	33	73	0.09	−0.5	4	5,688	se.	38	n.	17	9	13	9	5.3	0.0	0.0
Roswell	3,566	75	85	26.41	30.13	+.09	33.2	−6.0	69	6	47	−2	18	20	42	27	20	64	0.26	−0.3	3	4,293	s.	31	w.	13	12	11	8	6.0	2.6	0.0
Southern Plateau							39.0	−1.7										60	0.65	0.0										4.4		
El Paso	3,778	152	175	26.21	30.06	+.05	43.8	−1.2	64	5	55	17	18	32	34	35	25	53	0.17	−0.3	4	6,627	nw.	41	sw.	13	16	10	5	3.6	0.0	0.0
Sante Fe	7,013	38	53	23.16	30.08	+.04	25.6	−3.2	44	4	35	−2	22	16	28	21	14	64	0.46	−0.2	9	3,796	n.	22	sw.	13	12	12	7	4.5	7.9	T.
Flagstaff	6,907	10	59	23.26	29.98	−.07	24.7	−2.0	50	4	36	−8	21	14	40	23		73	2.93		12	6,337	sw.	32	s.	10	8	9	14		32.2	6.0
Phoenix	1,108	10	107	28.86	30.03	.00	52.0	+0.8	75	4	62	30	8	42	34	44	35	60	1.69	+0.9	11	3,424	e.	26	s.	10	9	11	11	5.3	0.0	0.0
Yuma	141	9	54	29.89	30.04	−.01	52.8	−1.6	74	4	64	29	9	41	35	44	32	51	0.28	−0.2	5	3,455	n.	22	n.	21	14	13	4	4.2	0.0	0.0
Independence	3,957	6	27	25.93	30.04	−.03	35.3	−2.9	62	4	46	4	12	24	30	28			0.65	−0.3	7		s.				4	15	12		7.0	0.0
Middle Plateau							22.1	−6.1										77	1.74	+0.7										6.1		
Reno	4,532	74	81	25.40	30.06	−.07	27.8	−4.7	55	3	38	−2	8	18	36	25	21	75	1.42	−0.1	14	3,221	se.	33	s.	4	5	16	10	6.1	16.7	T.
Tonopah	6,090	12	20				26.6		44	28	33	4	13	20	20	23	18	73	0.35		6		se.									
Winnemucca	4,344	18	56	25.59	30.13	−.03	19.6	−9.0	56	4	30	−21	21	9	37	18	15	82	2.29	+1.3	17	4,924	ne.	31	nw.	19	7	14	10	5.7	25.5	9.0
Modena	5,473	10	43	24.55	30.07	−.03	20.4	−6.3	49	3	33	−17	8	8	43	18	14	80	1.89	+1.0	10	6,265	w.	47	sw.	5	11	8	12	5.5	19.5	4.0
Salt Lake City	4,360	163	203	25.61	30.11	−.04	23.6	−5.6	52	5	31	−4	22	16	32	21	16	70	1.38	+0.1	11	4,191	s.	36	s.	5	8	5	18	6.7	23.3	6.2
Grand Junction	4,602	60	68	25.40	30.12	+.06	19.2	−4.8	55	5	29	−18	22	10	33	17	13	83	1.73	+1.1	15	2,843	nw.	31	s.	5	7	9	15	6.7	20.9	6.8
Northern Plateau							15.5	−13.2										77	1.24	−0.4										6.6		
Baker	3,471	48	53	26.47	30.23	+.07	12.0	−12.9	46	4	21	−22	17	3	31	12	8	80	0.86	−0.5	16	3,537	se.	20	sw.	5	4	10	17	7.2	16.7	8.1
Boise	2,739	78	86	27.25	30.24	+.05	17.9	−11.9	57	4	26	−17	23	10	25	16	12	78	2.18	+0.4	18	2,870	nw.	25	se.	4	4	7	20	7.5	26.8	8.3
Lewiston	757	40	48	29.41	30.27	+.11	16.3	−16.2	64	4	24	−17	18	8	30				1.12	−0.4	14	1,886	e.	19	w.	1	7	9	15	6.4	11.5	1.8
Pocatello	4,477	60	68	25.46	30.19	−.01	15.4	−9.3	48	5	26	−22	17	5	45	14	9	76	1.32	−0.1	17	5,158	se.	29	s.	4	7	8	16	6.4	20.0	3.0
Spokane	1,929	101	110	28.10	30.25	+.13	16.2	−11.3	52	4	24	−8	21	8	26	15	9	71	0.85	−1.3	6	2,972	ne.	22	e.	16	12	6	13	5.3	10.8	6.5
Walla Walla	991	57	65	29.15	30.28	+.13	15.1	−17.6	59	4	21	−15	22	9	27	13	10	82	1.13	−0.8	10	2,409	s.	26	w.	4	7	5	19	7.0	13.6	7.5
North Pacific Coast Region							30.3	−8.1										76	3.00	−2.8										6.6		
North Head	211	11	56	29.82	30.06	+.01	33.2	−8.9	50	29	38	18	17	29	14	31	26	73	3.80	−5.0	17	9,426	e.	50	s.	31	10	6	15	6.0	0.2	0.0
Port Angeles	29	8	53		30.13		30.6		54	2	36	13	17	25	23				1.89	−2.6	12	4,937	s.	27	n.	19	8	10	13		3.8	0.0
Seattle	125	215	250	29.97	30.10	+.05	32.8	−6.7	50	1	38	18	11	28	17	30	24	70	2.62	−2.3	13	4,608	ne.	34	s.	2	13	5	13	5.4	6.5	0.0
Tacoma	194	172	201	29.89	30.10	+.06	32.3	−6.5	55	31	39	12	21	26	30				2.83	−3.3	13	5,490	n.	31	ne.	16	10	8	13	6.3	7.5	0.0
Tatoosh Island	86	9	53	29.95	30.05	+.07	35.8	−5.4	48	31	38	24	16	33	10	33	29	76	5.52	−6.3	13	17,947	e.	72	e.	16	13	5	13	5.4	6.9	0.0
Yakima	1,076	58	67	29.06	30.28		15.7	−11.7	52	1	24	−15	21	7	27	14	6	64	0.52	−0.8	8	2,504	se.	23	sw.	4	12	6	13	5.5	7.0	4.0
Medford	1,329	29	58	28.50	30.05		31.2		58	29	39	−3	11	24	28	31	29	90	2.45	−0.3	17		n.	33	se.	4	1	7	23	8.3	22.6	0.0
Portland, Oreg	153	68	106	29.96	30.13	+.05	28.0	−11.4	54	1	33	13	17	24	16	25	19	68	3.43	−3.2	16	5,396	e.	28	e.	16	6	5	20	7.2	16.4	2.6
Roseburg	510	75	99	29.49	30.06	−.04	34.2	−7.0	60	31	40	17	13	29	23	33	31	88	3.94	−1.4	19	2,284	nw.	18	sw.	5	0	9	22	8.6	11.9	0.0
Middle Pacific Coast Region							46.1	−1.2										82	4.46	−0.2										6.6		
Eureka	62	73	89	29.98	30.05	−.05	45.4	−1.5	60	28	52	27	11	39	23	44	42	86	6.32	−0.8	17	3,863	se.	29	sw.	5	5	7	19	7.0	0.1	0.0
Red Bluff	330	5	58	29.68	30.05	−.06	42.8	−3.0	66	31	50	20	13	36	27	40	36	78	3.87	−0.9	13	3,829	nw.	29	se.	4	8	6	17	6.7	5.0	0.0
Sacramento	69	106	117	29.98	30.05	−.07	44.4	−1.4	63	31	50	28	13	38	24	43	41	86	3.65	−0.1	14	4,796	se.	32	se.	12	8	10	13	6.0	1.0	0.0
San Francisco	155	208	243	29.86	30.04	−.07	49.6	−0.3	67	31	54	37	11	45	17	46	43	78	4.99	+0.4	14	4,188	n.	26	nw.	12	5	10	16	6.7	0.0	0.0
San Jose	141	12	110	29.90	30.05		48.2	−0.1	66	29	56	27	8	40	29				3.49	+0.5	15	3,670	nw.	25	se.	4	4	11	16	6.8	0.0	0.0
South Pacific Coast Region							52.7	+1.0										70	3.79	+1.5										6.6		
Fresno	327	89	98	29.70	30.07	−.03	46.4	+0.2	68	3	54	28	2	39	36	44	40	77	1.90	+0.2	10	3,062	nw.	18	se.	12	5	10	16	6.9	2.5	0.0
Los Angeles	338	159	191	29.67	30.04	−.04	56.0	+1.4	78	2	63	36	11	49	28	48	40	62	5.57	+2.5	9	3,822	ne.	30	ne.	11	9	9	13	5.8	0.0	0.0
San Diego	87	62	70	29.94	30.03	−.04	55.8	+1.5	72	3	62	41	8	50	24	50	45	72	3.90	+1.8	13	3,895	nw.	28	s.	11	5	7	19	7.0	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.96	30.05		74.2	−0.8	82	31	79	66	10	69	13				6.14	+1.5	26	9,181	e.	38	e.	3	6	23	2	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	[1]29.77	[1]29.90	+.02	79.7	−0.2	90	19	88	69	8	71	19			[2]77	0.05	−0.8	2	6,831	n.	24	n.	5	4	24	3	4.8	0.0	0.0
Cristobal	38	7	97	[1]29.85	[1]29.88	+.01	80.6	−0.9	86	20	85	74	25	76	12	74	72	[2]77	2.46	−1.1	23	10,478	n.	26	n.	3	9	21	1	4.3	0.0	0.0
Alaska																																
Fairbanks	455	11	44	[1]29.90	[1]30.49		−5.2		40	8	5	−38	3	−15	37	−7	−10	83	0.31		6		n.				19	2	10	4.0	5.5	13.1
Juneau	80	11	50	[1]30.23	[1]30.33		23.4		42	16	29	7	3	18	20	21	12	60	0.91		5	5,080	e.	43	ne.	14	20	3	8	3.1	8.6	6.6
Hawaiian Islands																																
Honolulu	38	86	100	[1]29.85	[1]29.89		70.5	−0.4	80	23	76	57	14	65	15	65	62	77	7.62	+3.8	14	5,077	n.	36	sw.	15	11	10	10	5.3	0.0	0.0

[1] Pressure not reduced to mean of 24 hours.

[2] Observations taken bihourly.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, January, 1930*

Stations	Altitude above mean sea level Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean maximum + mean minimum ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	°F.	°F.	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
Cape Race, N. F.	99				23.1		31.6	14.5	42	1	2.63		14.3
Sydney, C. B. I.	48	30.12	30.17	+0.24	20.8	+0.3	30.5	11.1	50	−7	4.98	−0.12	28.0
Halifax, N. S.	88	30.08	30.19	+.22	24.6	+2.8	32.9	16.4	53	−1	4.91	−0.86	14.3
Yarmouth, N. S.	65	30.06	30.13	+.13	28.3	+2.0	35.2	21.4	51	6	3.88	−1.28	23.1
Charlottetown, P. E. I.	38	30.07	30.11	+.15	17.0	0.0	26.0	8.0	48	−13	4.43	+0.47	34.0
Chatham, N. B.	28	30.04	30.08	+.11	9.9	+0.1	21.4	−1.7	50	−27	2.93	−0.66	22.7
Father Point, Que.	20	30.12	30.15	+.17	9.2	+1.2	18.0	0.5	46	−12	3.26	+0.41	20.6
Quebec, Que.	296	29.84	30.19	+.17	13.0	+3.9	19.9	6.1	43	−15	6.71	+2.70	38.6
Doucet, Que.	1,236				−0.2		12.1	−12.4	42	−47	0.25		2.0
Montreal, Que.	187	29.94	30.16	+.12	17.6	+5.9	25.7	9.6	44	−15	5.26	+1.53	28.8
Ottawa, Ont.	236	29.90	30.19	+.16	15.5	+5.9	24.3	6.7	45	−20	3.06	+0.07	15.0
Kingston, Ont.	285	29.85	30.19	+.14	21.3	+4.2	28.0	14.6	45	−15	3.14	−0.31	5.8
Toronto, Ont.	379	29.75	30.18	+.13	22.8	+1.4	28.9	16.7	47	−4	3.33	+0.41	13.1
Cochrane, Ont.	930				−1.7		7.5	−10.9	35	−30	0.96		9.6
White River, Ont.	1,244	28.68	30.09	+.08	−5.5	−5.1	9.6	−20.6	35	−47	1.04	−0.65	10.4
London, Ont.	808				19.5		26.2	12.9	44	−9	5.84		19.2
Southampton, Ont.	656	29.38	30.13	+.10	19.9	−0.5	25.6	14.2	48	−9	4.61	+0.56	34.2
Parry Sound, Ont.	688	29.40	30.14	+.13	15.3	+1.5	22.4	8.3	40	−26	7.32	+3.24	62.1
Port Arthur, Ont.	644	29.41	30.18	+.11	2.4	−0.7	10.9	−6.2	36	−28	0.68	−0.14	6.8
Winnipeg, Man.	760												
Minnedosa, Man.	1,690	28.27	30.24	+.14	−7.8	−0.6	1.2	−16.7	27	−44	0.16	−0.64	1.6
Le Pas, Man.	860				−13.4		−4.7	−22.1	23	−44	0.40		4.0
Qu'Appelle, Sask.	2,115	27.82	30.25	+.17	−7.8	−4.0	−0.5	−15.0	16	−44	0.30	−0.20	3.0
Moose Jaw, Sask.	1,759				−4.7		3.7	−13.1	27	−37	0.20		2.0
Swift Current, Sask.	2,392	27.52	30.24	+.15	−2.4	−5.5	4.4	−9.1	26	−38	0.39	−0.25	3.9
Medicine Hat, Alb.	2,144												
Calgary, Alb.	3,428												
Banff, Alb.	4,521												
Prince Albert, Sask.	1,450	28.62	30.34	+.25	−10.0	−1.6	−0.6	−19.5	21	−56	0.45	−0.52	4.5
Battleford, Sask.	1,592	28.44	30.33	+.25	−7.1	−1.2	0.7	−14.9	22	−50	0.32	−0.08	3.2
Edmonton, Alb.	2,150												
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.85	30.11	+.14	32.0	−6.5	36.0	28.1	47	16	1.10	−4.29	1.8
Barkerville, B. C.	4,180												
Estevan Point, B. C.	20												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151												

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Stations	Altitude above mean sea level Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean maximum + mean minimum ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
Father Point, Que.	20	30.00	30.03	+.08	11.2	−4.2	17.7	4.6	35	−11	3.66	+0.83	36.6
Quebec, Que.	296	29.72	30.06	+.05	13.6	−1.6	18.7	8.5	35	−11	4.11	+0.42	40.3
Kingston, Ont.	285	29.72	30.06	+.02	21.6	−2.1	27.3	16.0	39	−6	1.91	−1.33	17.1
Winnipeg, Man.	760	29.24	30.14	+.12	3.9	−0.2	10.6	−2.8	40	−28	1.45	+0.54	14.3
Medicine Hat, Alb.	2,144	27.66	30.02	+.05	17.1	−1.1	25.0	9.2	50	−27	0.29	−0.26	2.9
Edmonton, Alb.	2,150	27.63	30.04	+.11	8.9	−4.2	16.5	1.3	43	−28	0.98	+0.28	9.5
Kamloops, B. C.	1,262	28.75	30.08	+.14	25.7	−3.2	30.1	21.4	54	−4	0.92	+0.14	8.5
Estevan Point, B. C.	20				41.2		45.5	36.8	50	28	12.57		5.4
Prince Rupert, B. C.	170				34.4		38.4	30.4	49	10	8.62		2.4

Chart I. Departure (°F.) of the Mean Temperature from the Normal, January, 1930

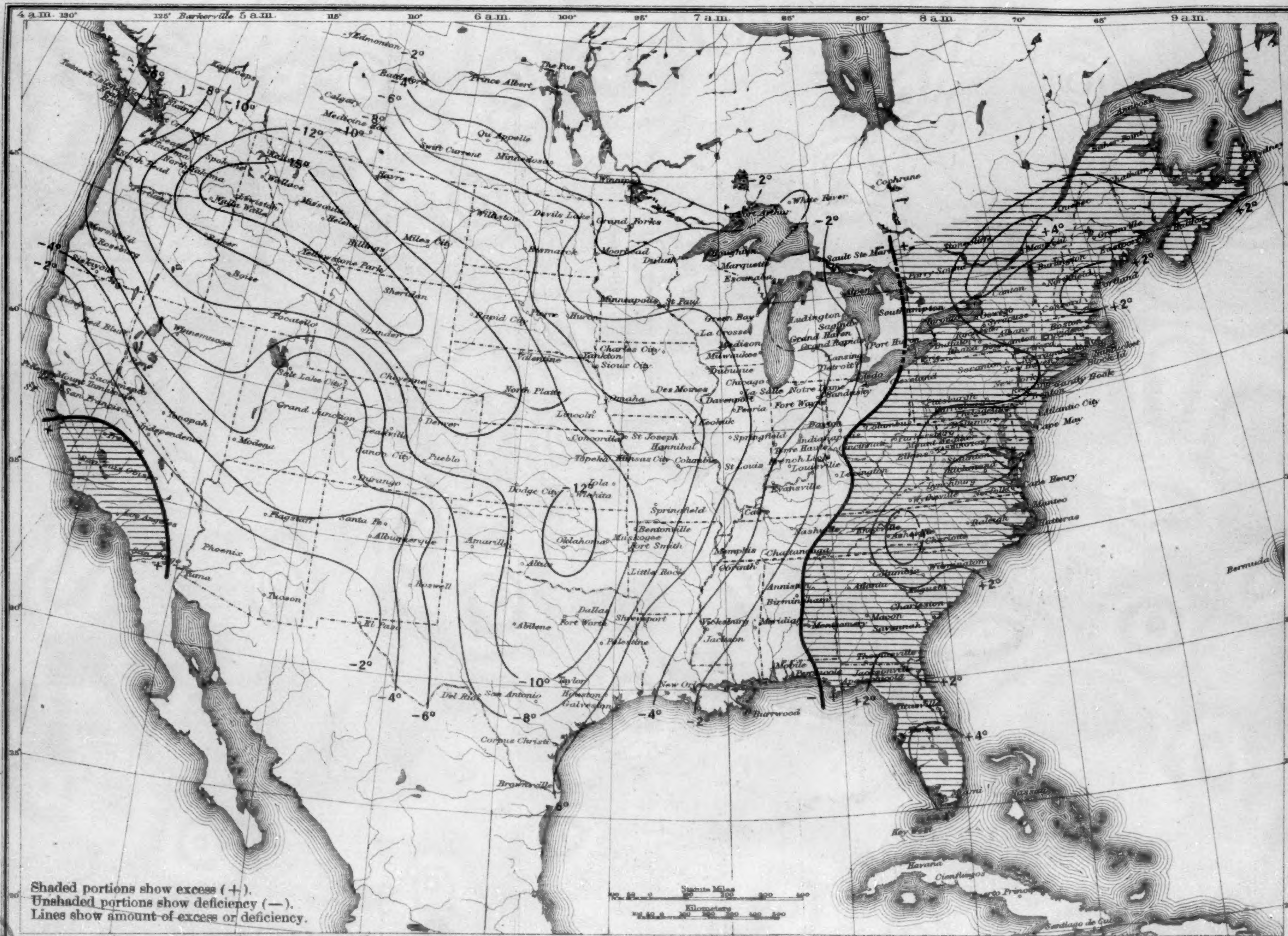

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Chart II. Tracks of Centers of Anticyclones, January, 1930. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Welby R. Stevens)

Chart III. Tracks of Centers of Cyclones, January, 1930. (Inset) Change in Mean Pressure from Preceding Month

Chart III. Tracks of Centers of Cyclones, January, 1930. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by Welby R. Stevens)

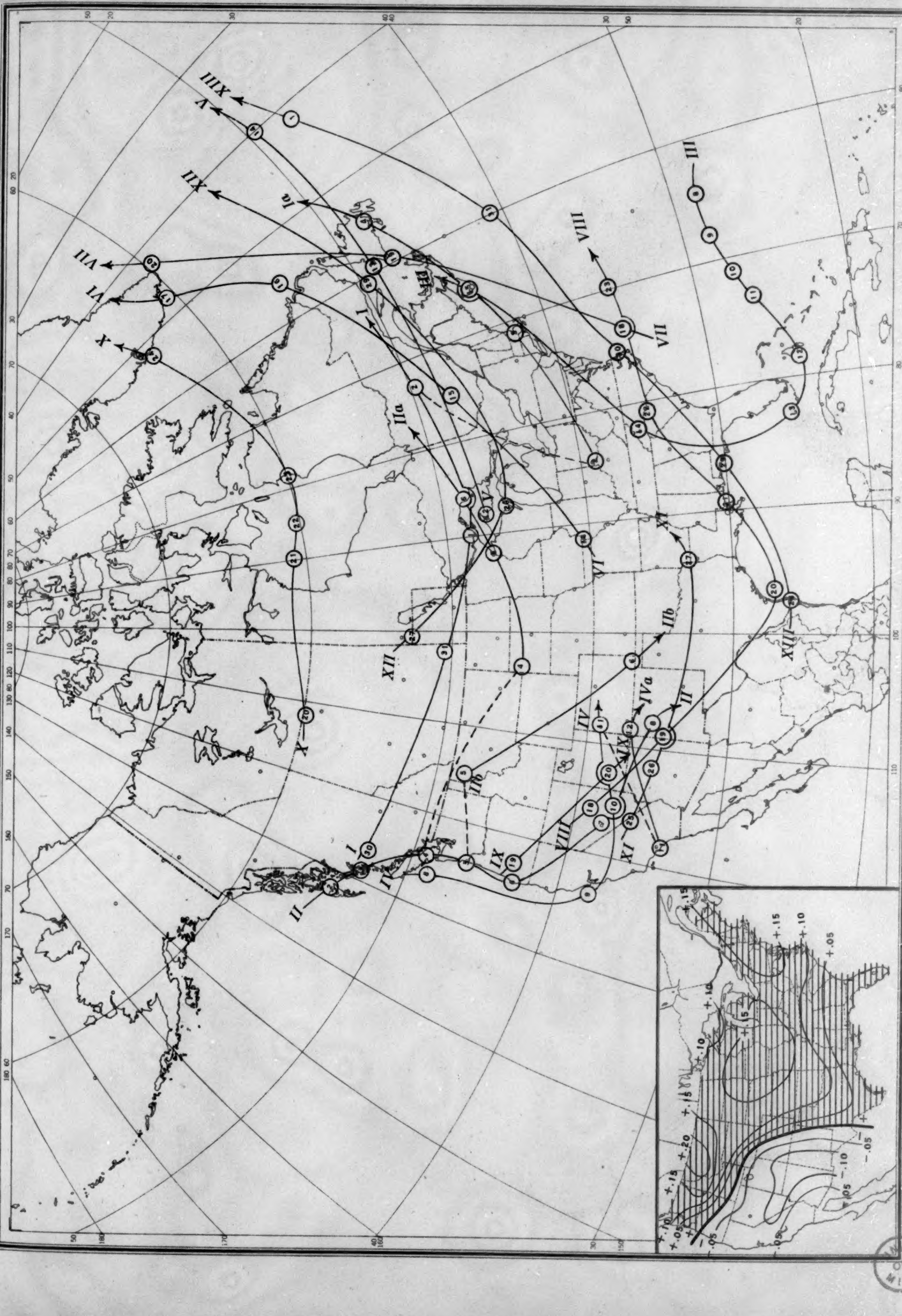

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Chart IV. Percentage of Clear Sky between Sunrise and Sunset, January, 1930

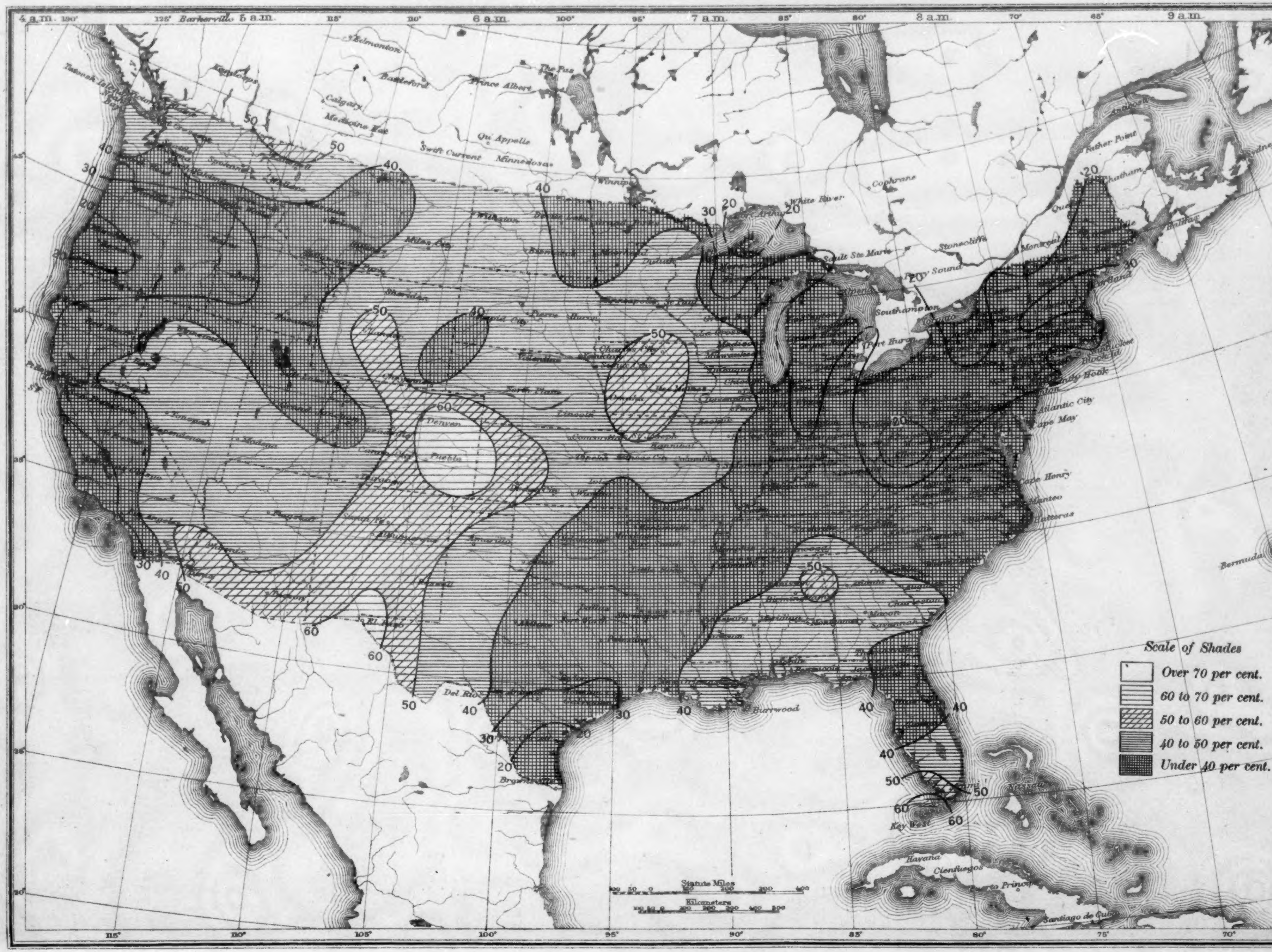

Chart V. Total Precipitation, Inches, January, 1930. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, January, 1930. (Inset) Departure of Precipitation from Normal

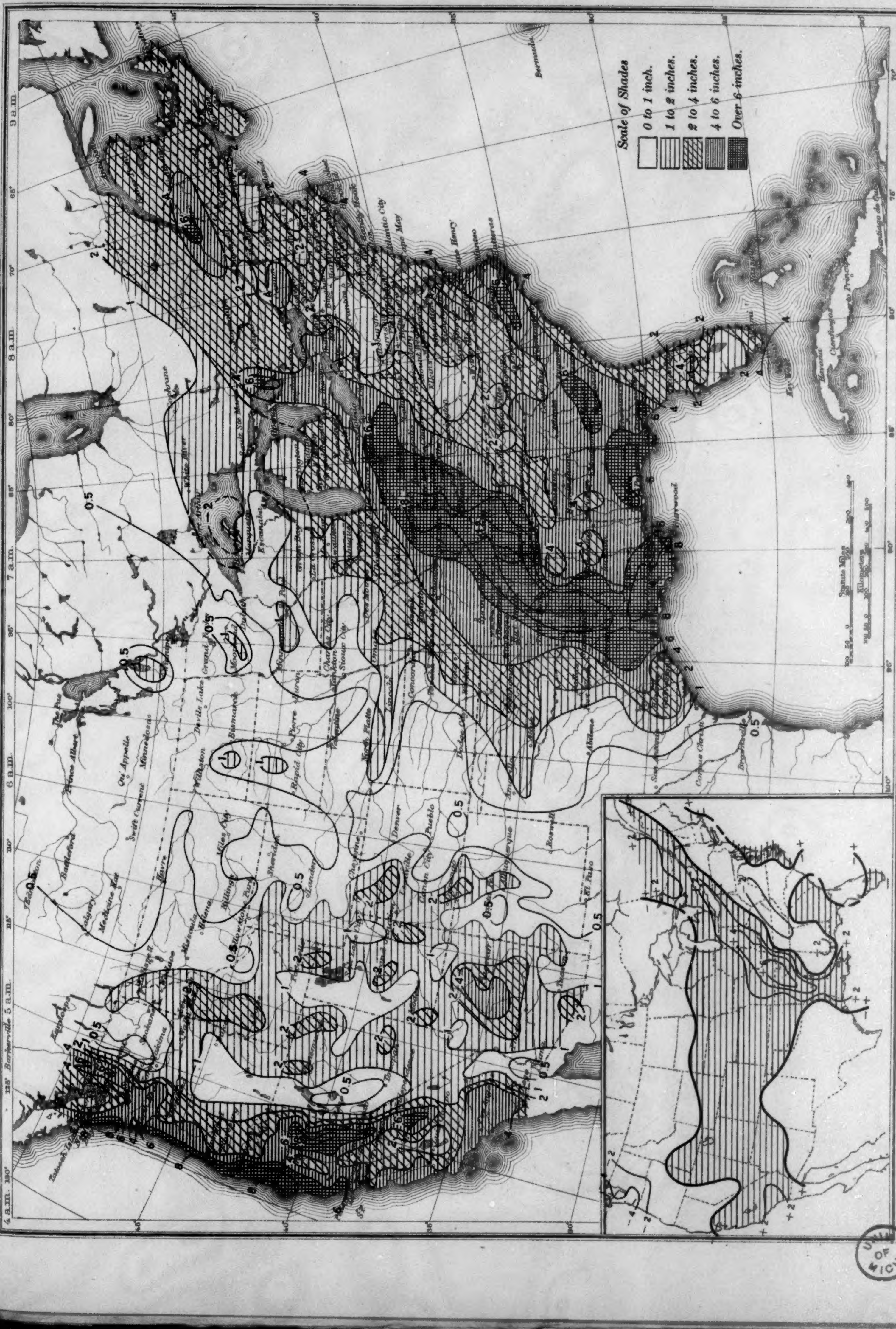

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Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, January, 1930

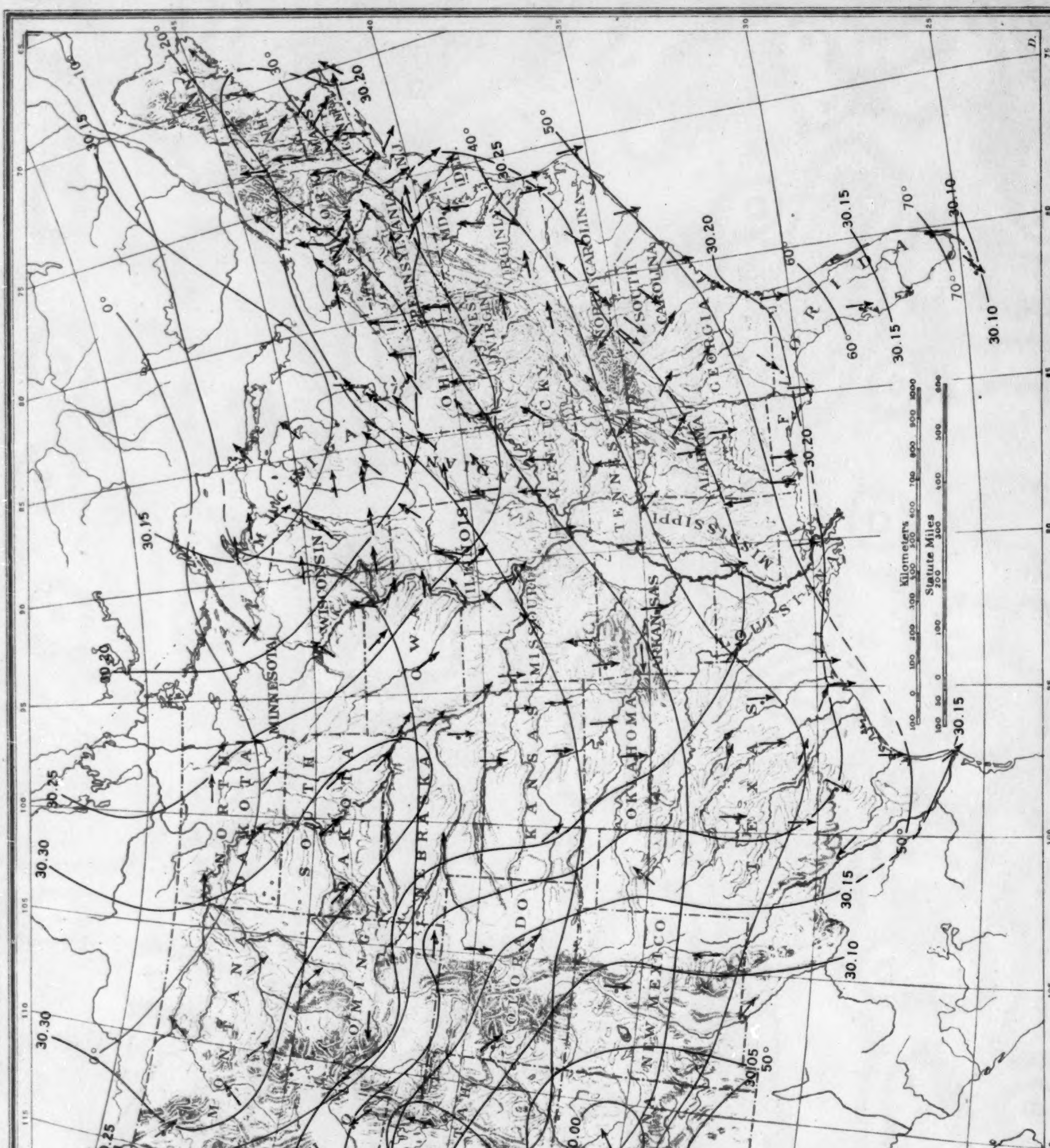

Chart VII. Total Snowfall, Inches, January, 1930. (Inset) Depth of Snow on Ground at end of Month

Chart VII. Total Snowfall, Inches, January, 1930. (Inset) Depth of Snow on Ground at end of Month

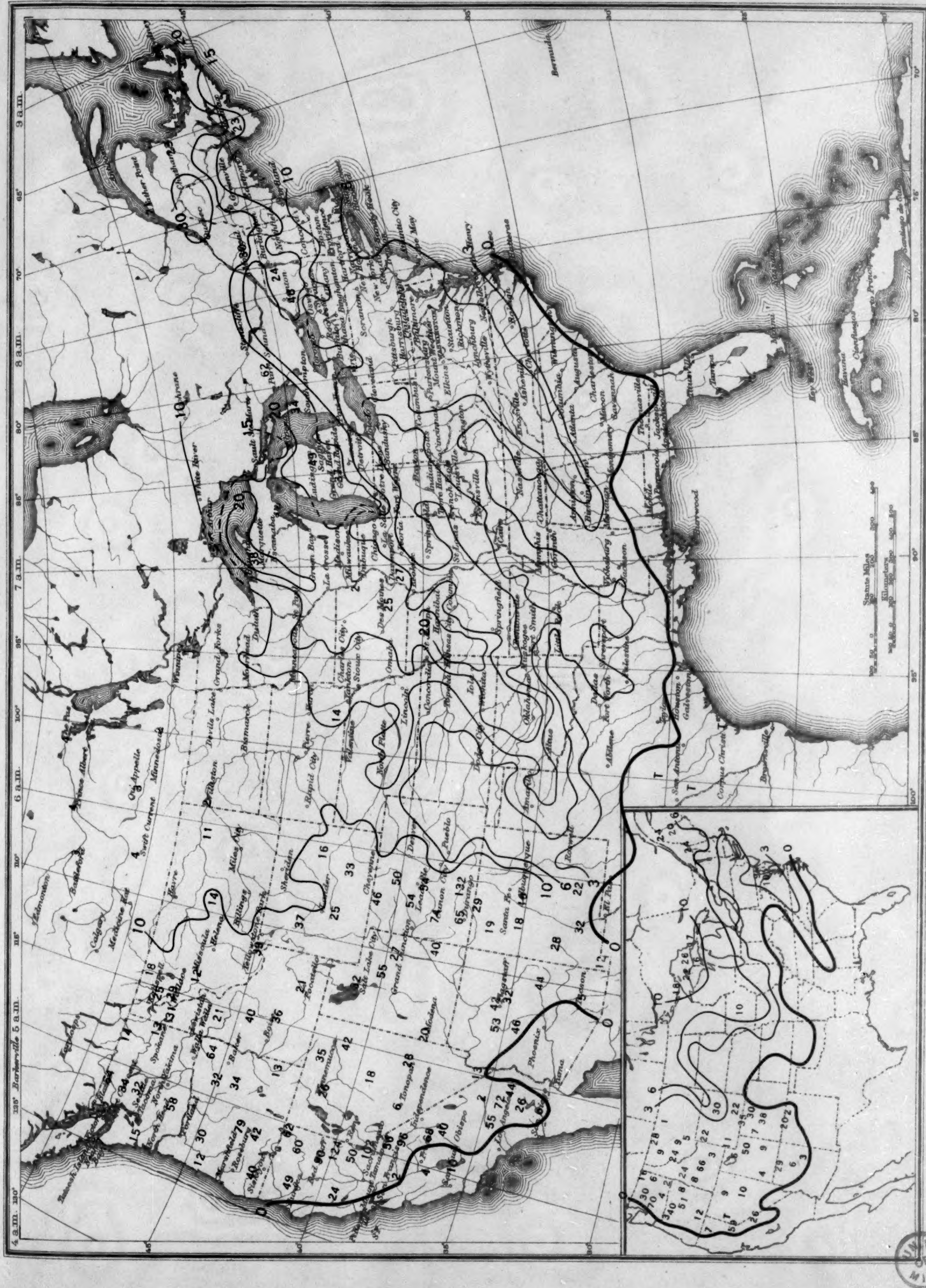

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Chart VIII. Weather Map of North Atlantic Ocean, January 28, 1930

Chart VIII. Weather Map of North Atlantic Ocean, January 28, 1930

(Plotted by F. A. Young)

Greenwich Mean Noon.

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicate force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁚ rain, ▲ hail or sleet, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.

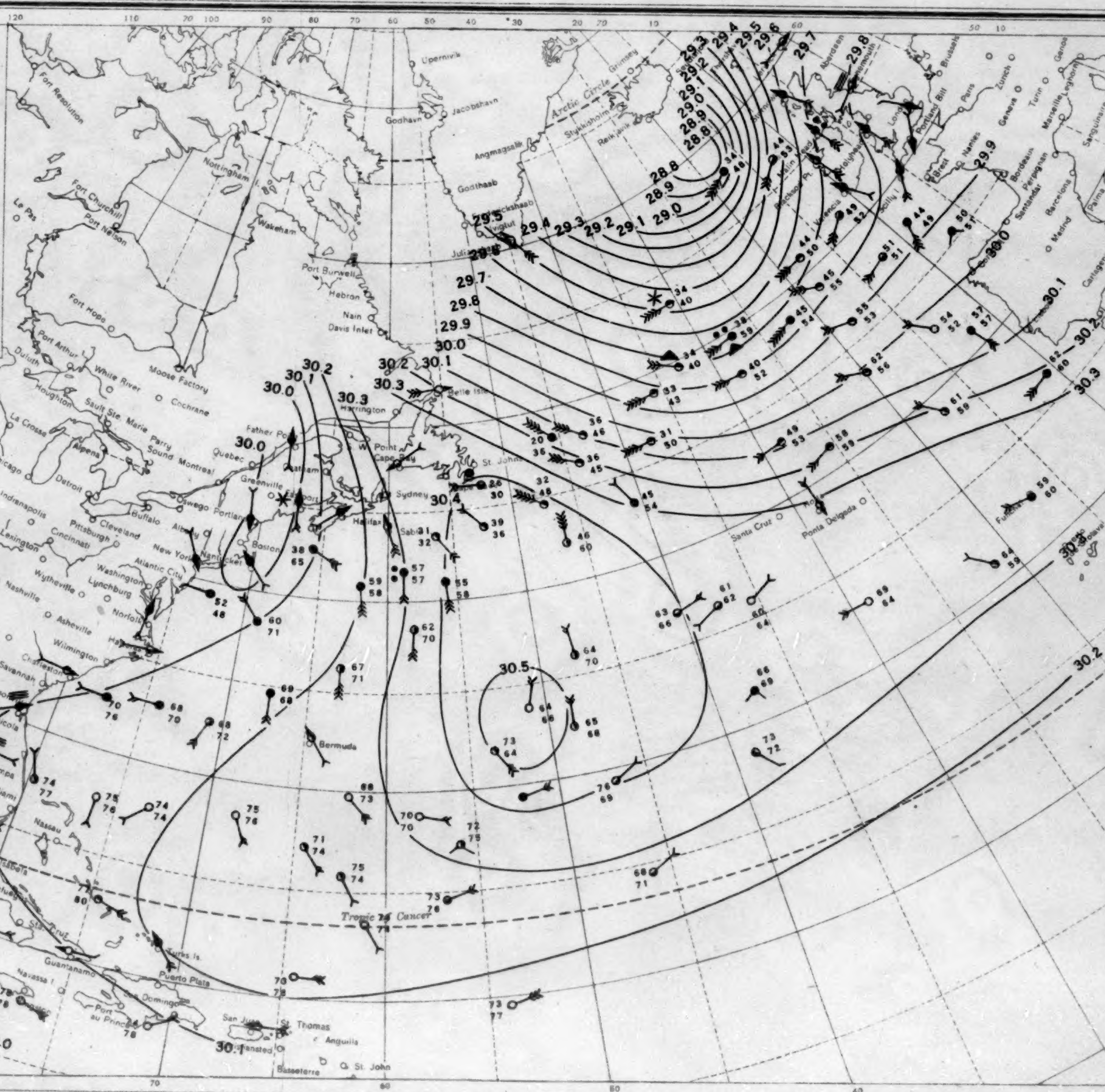

Chart IX. Weather Map of North Atlantic Ocean, January 29, 1930

(Plotted by F. A. Young)

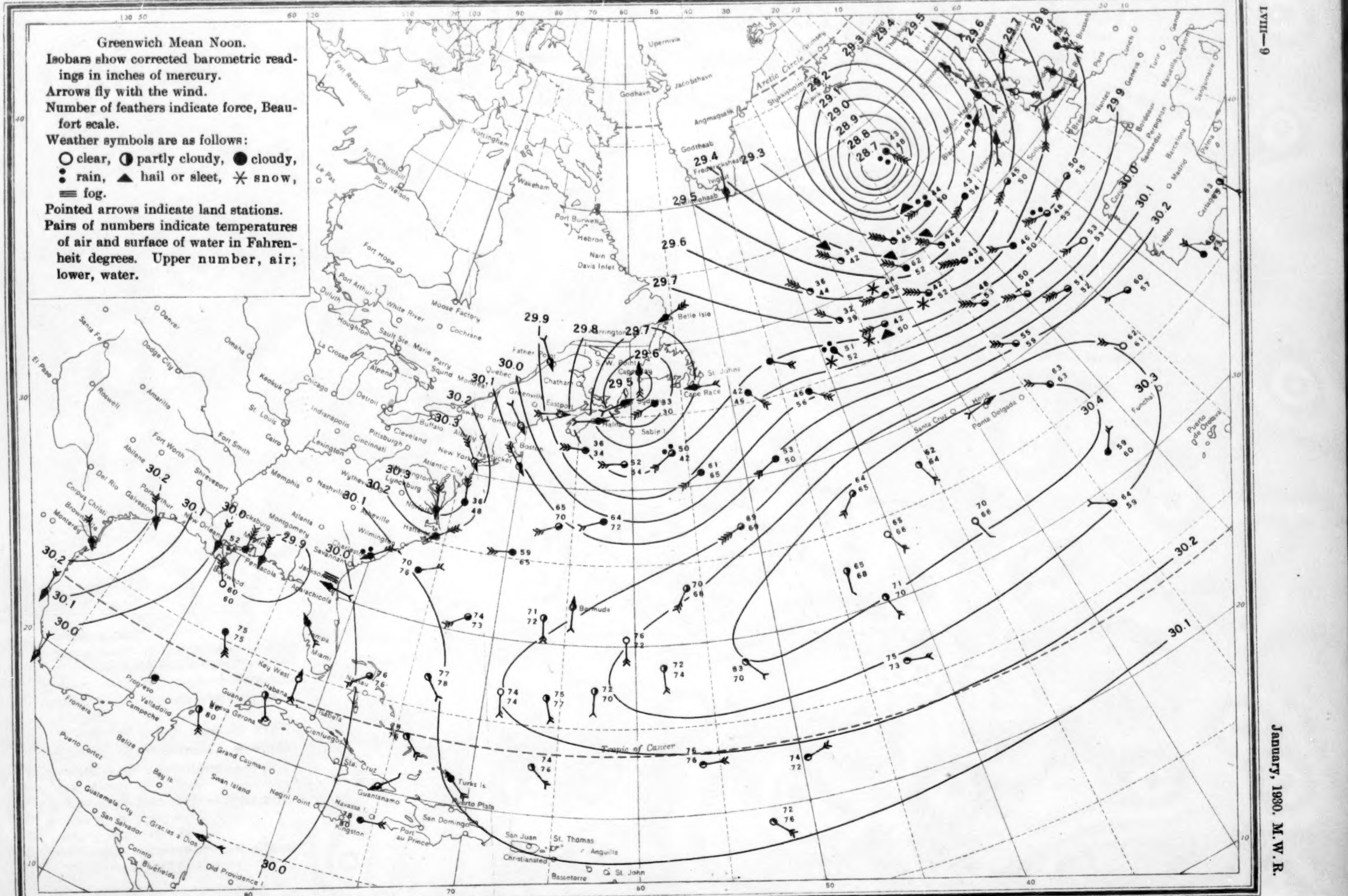

Chart X. Weather Map of North Atlantic Ocean, January 30, 1930

Chart X. Weather Map of North Atlantic Ocean, January 30, 1930
(Plotted by F. A. Young)

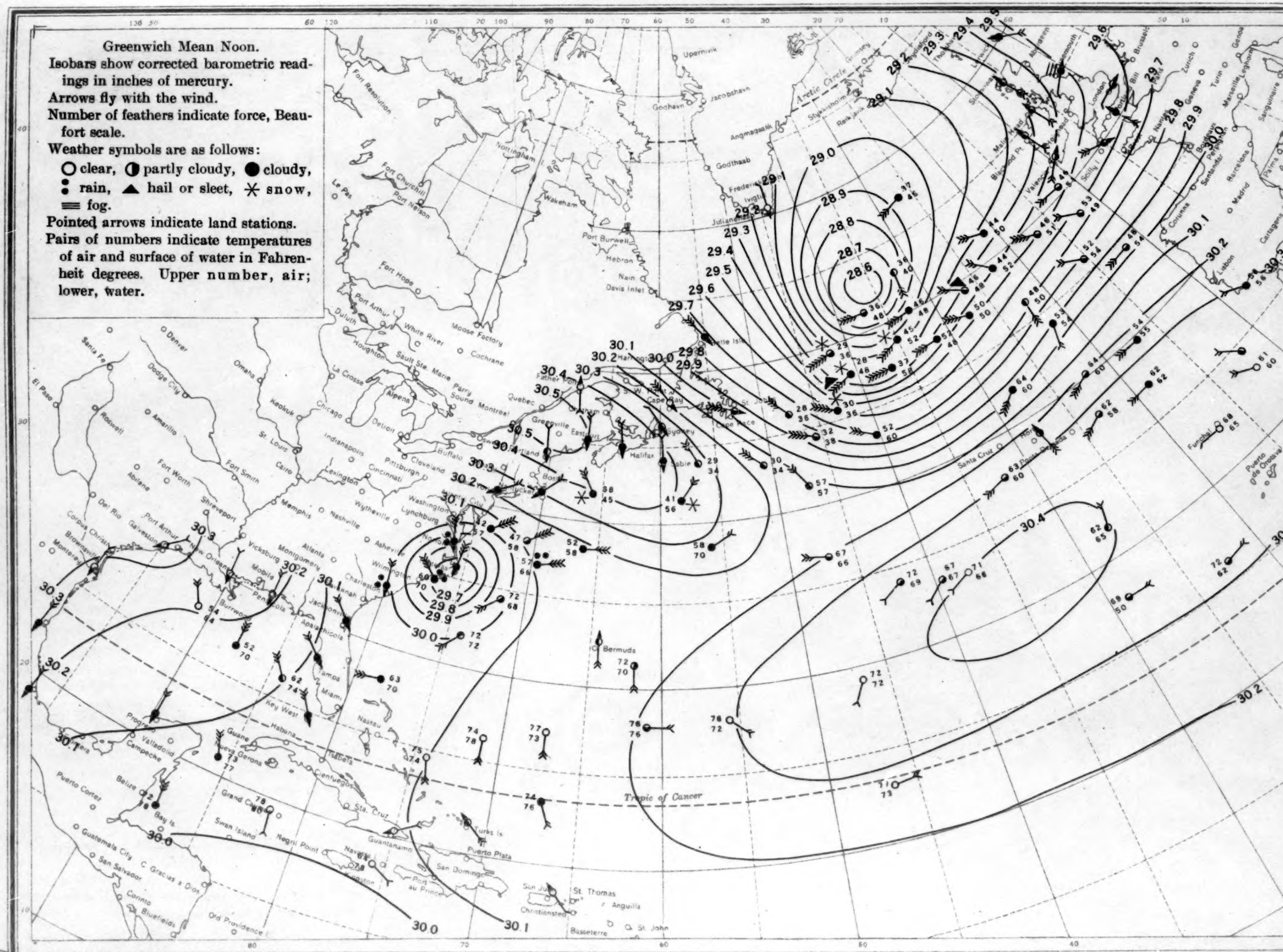

Chart XI. Weather Map of North Atlantic Ocean, January 31, 1930

(Plotted by F. A. Young)